CM-217
Project 2.1
CZ130

MOULTRIE CREEK - MOSES CREEK WATERSHED

BASIN MANAGEMENT PROJECT

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Supported Through

Florida Department of Environmental Regulation
(DER Contract No. CM-217)

(Funds for this project were provided by the Department of Environmental Regulation, Office of Coastal Management using funds made available through the National Oceanic and Atmosphere Administration under the Coastal Zone Management Act of 1972, as amended.)

With the Technical Assistance from

U. S. Army Corps of Engineers
Jacksonville District
Through
U. S. Army Corps of Engineers
State Planning Assistance (Section 22) Program

January 1990

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FOREWORD

In October 1987 the Florida Department of Environmental Regulation (DER) provided a grant to St. Johns County to undertake this study of the Lower Matanzas River–Moultrie Creek-Moses Creek Watersheds out of concern for the water quality degradation previously observed in the Matanzas River (DER contract No. CM–207). A previous report produced under the Florida Coastal Management Program (1979) had identified septic tank effluent discharges and non–point source pollution (including storm drainage) as major threats to shellfish growing areas in the Matanzas River. The first phase of the study was completed in May 1989. The Phase 1 activities consisted of data collection, development of evaluation methods and techniques, initial Geographic Information system development, and presentation of general conditions found within the Moultrie Creek–Moses Creek watersheds.

The St. Johns County Commission responded to the estuarine water quality problem identified in the original DER 1979 study through the adoption of a County-wide drainage ordinance in 1986. In spite of these actions, the shellfish growing areas and the general quality of estuarine waters within the St. Augustine area continue to be threatened.

In August 1988 St. Johns County requested, through DER, U. S. Army Corps of Engineers (Corps) technical assistance in evaluating water resource conditions related to the St. Johns County stormwater management concerns already under study through the DER grant. The Corps can participate in water related planning investigations under the authority of Section 22, Water Resources Development Act of 1974 (Public Law 93–251). This law provides authority for cooperating with any state in the preparation of comprehensive plans for water resources development, utilization, and conservation. The Corps of Engineers produced partial report materials for local review in September and October 1989. A draft document completing the Corps of Engineers participation in this study was submitted for finalization by the St. Johns County Engineering Department in November 1989.

This Phase 2 report in response to DER contract CM–217 provides an overview of the water resource management problems in St. Johns County using the Moultrie Creek and Moses

Creek watershed as an example area. The report responds to the DER grant purpose of developing a basis for County-wide improvements in stormwater management, flood protection, and protection of natural resources. The report incorporates the findings of the Phase 1 efforts of the study activities and subsequent information development undertaken through this second phase of the study. The report also provides information for use by St. Johns County in the development of a comprehensive plan in response to State of Florida growth management requirements.

Finally, the primary focus of this report must be oriented towards the satisfaction of the DER contract requirements. The content of the Study Process for DER contract CM-217 appears in the Appendix. Emphasis has been given in the organization and content of this report to address contract required topics.

A component of this study, of interest to the Florida Department of Environmental Regulation, is the St. Johns County Engineering Department's progress in developing a geographical information system. This system has great potential for use as a basis for evaluating existing stormwater related problems and potential impacts resulting from proposed new developments. The study identifies some of the technical constraints accompanying the establishment of such a program.

In support of the report findings and recommendations, the County has initiated a computerized Geographic Information system (GIS) to most efficiently manage local government operations, including evaluation of proposed developments and improvements to existing facilities. The GIS is being designed as a product of this basin management program to address several of the tasks within the contractual scope of work. The GIS has many practical applications including near instantaneous updating of graphical information layers illustrating land use and cover, approved development layouts, soil types, topography, ownership boundaries, easements for drainage, septic facility location, wetland boundaries, significant archeological features, zoning, access, utility location, and other characteristics. All of these layers can be used singularly or in combination to evaluate new development proposals and rezonings, modify major utility lines, upgrade existing facilities, identify significant natural and cultural resource areas, and evaluate new transportation corridors. The GIS has tremendous potential for local and regional applications. The GIS is a highlight of this study because it serves as the mechanism to incorporate the objectives of the study within daily local government operations.

In an effort to enhance the capabilities of the GIS system, the County requested, and was granted permission by DER to acquire a Computer Aided Drafting and Design work station to develop the priority components of the initial stormwater management plan. The CAD system will be used to input new development plans such as Plats, rezonings, DRI's, stormwater management system plans, utility location and other information directly into the GIS system as well as assist the County in inputting existing basin information to be considered in the review of new development proposals into the GIS.

The report is also intended as a document through which the Florida Department of Environmental Regulation can provide guidance to other local governments on problems to be anticipated in establishing technologically advanced stormwater management procedures. The development of local government procedures for approaching stormwater management from a regional or watershed perspective is still evolving. The study brings together information on aspects of stormwater related problems in the Moultrie Creek and Moses Creek watershed and identifies management procedures for addressing these problems.

To identify parallel management methods used by other local governments, this study included the review of applicable stormwater management related ordinances used by a variety of other local governments in Florida. Guidance from some of these ordinances has been incorporated in this study. In general, large metropolitan governments in Florida have, in varying degrees, recognized and addressed watershed management needs. Acceptable mechanisms by which smaller governmental bodies can resolve the regional aspects of stormwater management still remain to be developed.

The study also provides information on changes of management processes within St. Johns County that may improve the effectiveness of local water management procedures. Local procedures for undertaking management changes is an internal County matter constrained by existing practices, public perception of need, available technical capabilities, and the County's financial resources or budget limitations. In practice, changes in local governmental operations generally evolve slowly. Each small change in procedure may result in unforeseen problems, and each problem must be resolved in a manner acceptable to all affected activities or departments.

Finally, each local government is a management entity different from any other government. The St. Johns County governmental structure is unique, and the manner in which changes can be accomplished in St. Johns County will be different than procedures adopted by any other government in

Florida. A significant management problem resolution process within the St. Johns County government extending over a period of time should be expected.

EXECUTIVE SUMMARY

This report focuses upon the stormwater management needs of St. Johns County using the Moultrie Creek and Moses Creek watersheds as an example area. Stormwater management, as used in this report, encompasses a range of interrelated water resource management problems of concern to local governments. Effective stormwater management within St. Johns County requires coordinated efforts between St. Johns County and municipal governments, between St. Johns County and the St. Johns River Water Management District, and among the several agencies within the County and municipal governments with special responsibilities for specific governmental functions identified in this report. While the St. Johns County Engineering Department is primarily responsible for enforcing the St. Johns County Paving and Drainage Ordinance 86-4, effective stormwater management requires an understanding of potential impacts of enforcement measures upon the complex factors that reflect upon the adequacy and quality of the County's water resources.

Stormwater management in the Florida environment must consider much more than the need to remove excess surface water from developed areas. The Florida Department of Environmental Regulation initiated this study as a means of assisting the County to establish practices that would protect the water quality of local area estuaries. While water quality concerns are important, this study also illustrates hydrology principles that must be applied to stormwater management and general water practices in order to preserve St. Johns County's ground water supplies and significant natural resource areas.

The State of Florida has determined that wetlands are important natural resources that must be protected by local and state governmental actions. This study identifies significant natural resource areas within the Moultrie Creek and Moses Creek watersheds and establishes some simplified criteria for determining, delineating, and protecting these areas. However, the study focuses primarily upon the engineering practices that can be used to permit development and still protect significant natural resource areas along stream courses and within uplands of watersheds.

As noted above, an important component of this report is the presentation of the relationship between stormwater management practices and the need to protect the ground water resources used by all residents living within the County. The inherent problems associated with the long-term practice of uncontrolled positive drainage consisting of the ditching, draining, and dropping of the local area ground water tables has been given emphasis.

This report has been organized to provide nontechnical readers with a general understanding of interrelated factors influencing surface and ground water resources within the County and to assist the reader in understanding the reasoning behind the need for improved forms of water resource management practices. At the same time, the report provides information intended for use by the St. Johns County Engineering Department. The information presented provides a framework for a long term program that will permit the Engineering Department to provide practical guidance to individuals interested in undertaking development efforts anywhere within the County.

As the pressure of urban growth of metropolitan Jacksonville continues to expand into St. Johns County, governmental procedures for reviewing proposed property improvements must become more efficient. Informal methods of permit processing and decision making acceptable in a slower paced governmental process cannot meet current nor expected future property development requirements. Property owners need clear, easily understood, and reasonable requirements that permit them to evaluate and undertake development actions. This report presents some criteria oriented towards the provision of necessary governmental services with objectives and procedures that are intended as clear and simplified guidance to property owners who desire to improve their properties.

BASIN MANAGEMENT FEATURES

Basin Management issues addressed in this report primarily include control of stormwater runoff, protection of natural resource areas, recharge and protection of the surficial aquifer, improvement and protection of surface water quality, and prevention of flooding due to rainfall events. Findings and recommendations are primarily addressed in chapters 9 and 11 of this report. The findings, criteria and recommendations discussed in this summary are not inclusive of all the findings and recommendations of this report. Also, the basin management problems identified in this report are interrelated and the long-term impact of these issues going uncorrected is tremendous.

Control of Stormwater Runoff

Erosion along the banks of the steep stream channels of Moultrie Creek occurs following heavy rainfalls. Unless stormwater is retained or detained on lands improved for development, accelerated eroded materials and contaminants from developed lands will be discharged into the Matanzas River in increasing quantities over time. As stormwater is diverted from recharge, the base flow of Moultrie Creek is being eliminated. The reduction in base flow of Moultrie Creek will contribute towards a decline in the ground water table, and an increase in salt water intrusion in the areas around Moultrie Creek.

Once stormwater from normal annual rainfall is retained, the overflow water from the infrequent and heavier rainfalls must be detained and safely discharged at controlled rates to avoid significant erosion and sedimentation and damages to receiving water areas.

Control of stormwater runoff can be accomplished through detention or retention storage in any land area capable of holding water without causing flooding of structure or roadways. Outlets can be raised to provide some areas for extended detention storage.

Protection of Natural Resource Areas

Development within or adjacent to the natural resource areas including the drainageway fringe will require consideration for the annual rise of the water table in these areas. Any effort to drain these lands will have long-term impacts on these areas and potential decline of the surficial aquifer supplies, potential decline of the natural resource area and potential of increased salt water intrusion. If the ground water table is lowered through either overdrainage or through deficient recharge, new growth of young plants and regeneration of new growth will be eliminated. As this occurs the natural area will begin a transitional process where vegetation that can sustain itself with less water will begin to replace the original species. Protection of significant natural areas in uplands can be accomplished through control of water table conditions.

The environmental health of the natural resource areas is dependent upon continual ground water seepage from adjacent higher water table areas and fresh water discharges from Moultrie Creek and tributary streams. Thus, ground water recharge in areas upland from natural resource areas is important for the continued prosperity of these areas. The prevention of polution discharge into natural resource areas and areas discharging to Moultrie Creek is also recommended for the future well being of the natural resource areas.

Recharge and Protection of the Surficial Aquifer

The unpredictable nature of precipitation makes control of ground water recharge both more difficult and important. Unless the stormwater systems are designed to detain or retain the routine daily rainfall amounts expected on an annual basis, overdrainage of the surficial aquifer will occur. Recharge to the surficial aquifer can only occur when rain water from normal rainfalls expected on an annual basis is retained long enough to infiltrate the surface and allowed to slowly percolate downward through the water table. Currently, withdrawals from the surficial aquifer for public water supplies are exceeding the natural rain water recharge in the areas of the well fields. From this, further declines in the local water table can be expected.

Uncontrolled drainage directed to Moultrie Creek removes stormwater before it can infiltrate to provide recharge to the surficial aquifer. Detention/retention storage or containment for ground water supply recharge through infiltration must be emphasized in the vicinity of the land surface areas beneath which surficial aquifer water is withdrawn. Increasing storage of stormwater and the diversion of stormwater towards cones of depressions are essential to avoid water table declines in the vicinity of the well fields.

Septic tank effluents are significant sources of water recharge to the surficial aquifer. Maximizing rainfall retention in these areas would serve to increase recharge and provide a means for diluting septic tank effluents. As the cone of depression from a well approaches the ground surface, septic tank effluents will be drawn downward which may introduce pathogens into the well water.

Recharge of the surficial aquifer is all important due to the extreme difficulty in rehabilitating wetlands following overdrainage. Overdrainage of ground water and uncontrolled drainage of stormwater contribute to the permanent and eventual lowering of the water table and should therefore be avoided.

Improvement and Protection of Surface Water Quality

Stormwater detention/retention facilities can help reduce pollutant loads characteristically found in urban runoff. Retention facilities designed to store the first one inch of every rainfall would more adequately serve water pollution control, water supply recharge, and significant natural resource area requirements. A number of small retention facilities provide a distributed and more effective system for ground water recharge than a single large retention facility.

The entrapment of contaminants from roadway traffic in retention storage catchment facilities along Moultrie Creek and the Matanzas River is vital for the preservation of the surface water quality of the Matanzas River. Surface water quality is also a victim of septic tank effluent which often contains materials toxic to the natural biological processes in the estuary. In addition, as development increases, the release of nutrients as septic tank effluents will also increase and will eventually overload those natural processes responsible for handling the effluent.

Prevention of Flooding Due to Rainfall Events

The actual frequency, duration and volume of rainfall events are unpredictable in St. Johns County, therefore it is important that an acceptable design be developed and adhered to on the County level. The 10-year 24 hour storm shall be used for design of stormwater infrastructure. Under recommendations of this stormwater management plan, construction of major roads and inhabited buildings will be located above the 100-year flood elevation. In addition, the controlled flow of stormwater has many advantages including prevention of the following: erosion of stormwater conveyance systems, sedimentation to downstream areas, accelerated eutrophication of downstream water bodies, and toxic materials entering receiving waters and degrading surface water quality.

Other Developmental Concerns

The annual high water table should be of great concern. The water table naturally fluctuates greatly. As the water table approaches within six inches of the subbase of a roadway the subbase can become saturated and cause deterioration of the subbase and eventual decay of the roadway. Also, as the water table approaches the bottom of retention facilities used for recharge, they cease to drain, can become flooded with ground water, and can cause flooding in the area contributing to the pond. It is for this reason that developments should be built above the annual high water table. In the past this was accomplished through drainage of the ground water. This has become an increasingly unacceptable practice as the longterm effects have become known.

This study serves as the basis for formulation of a County wide program for improvements in stormwater management, flood protection, and protection of natural resources. This report has identified problems, offered recommendations for improvement, and presented alternatives in use by other local governments to meet the challenges proposed by the ever increasing demands from growth upon County governments throughout Florida.

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LIST OF ABBREVIATIONS

B.C.C. – St. Johns County Board of County Commissioners

CAD/GIS – Computer Aided Design/Geographic Information System

Corps - U. S. Army Corps of Engineers

cfs – cubic feet per second

DER - Florida Department of Environmental Regulation

EPA - Environmental Protection Agency

ET - Evapotranspiration

FEMA - Federal Emergency Management Agency

FIRM - Flood Insurance Rate Maps

gpcd – gallon per capita day

IFAS – Florida Institute for Food and Agricultural Sciences

mg/l - milligrams per liter

NGVD - National Geodetic Vertical Datum

NOAA - National Oceanic and Atmospheric Administration

NRC - National Research Council

NWS - National Weather Service

ppm - parts per million

SCS - U. S. Soil Conservation Service

SFWMD - South Florida Water Management District

SJRWMD – St. Johns River Water Management District

U.S.D.A. - United States Department of Agriculture

USGS - United States Geological Survey

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AREA ORIENTATION

STUDY AREA

General

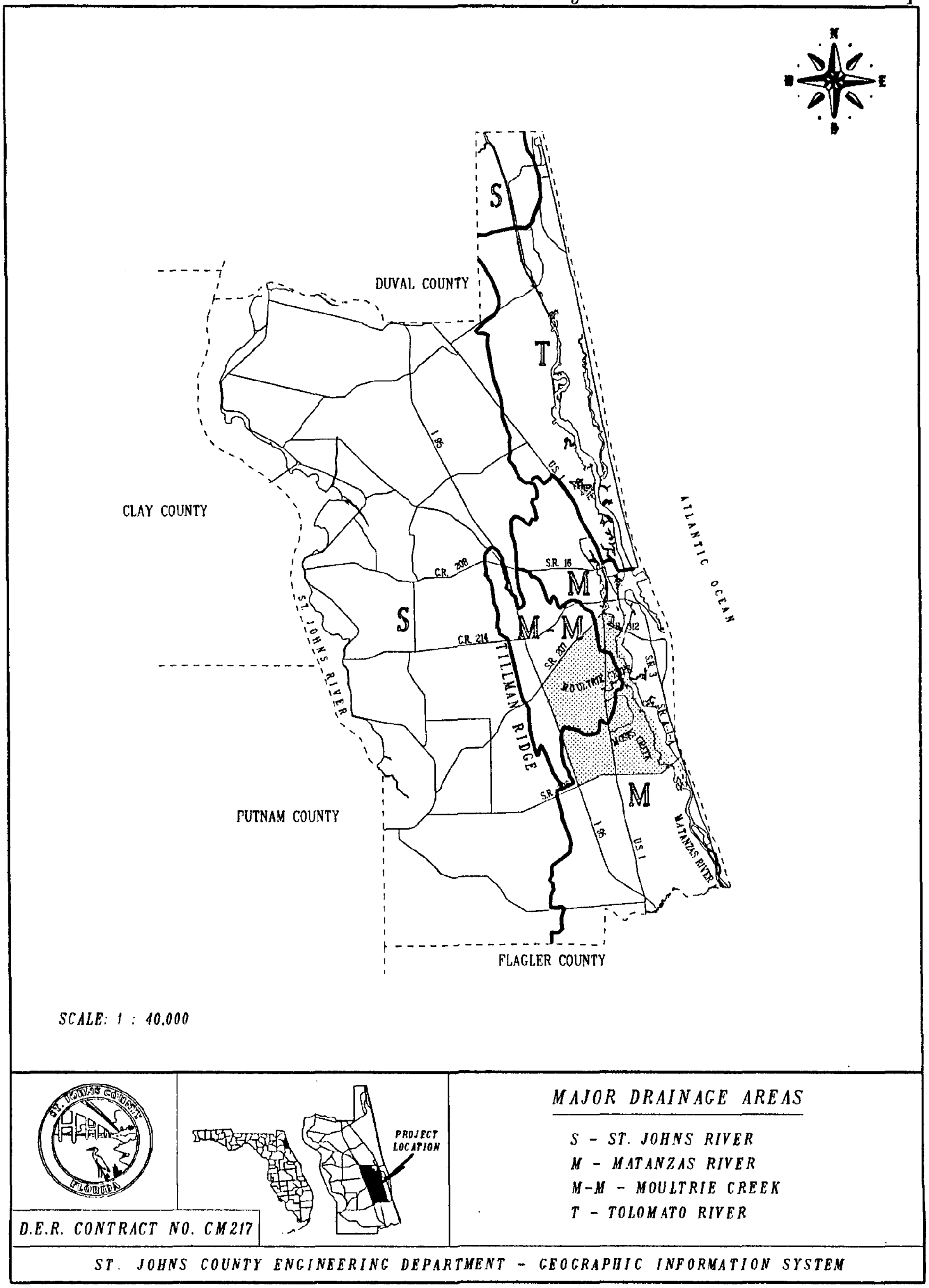
St. Johns County is located in northeast Florida with about 42 miles of coastline bordering the Atlantic Ocean (**Figure 1-1. Orientation Map**). The County is bounded on the north by Duval County and on the south by Flagler County. On the west and from the County's southwest corner to Deep Creek, St. Johns County abuts Putnam County. From Deep Creek northward, the western boundary of the County abutting Putnam and Clay counties is within the St. Johns River.

The study area is in the southeastern part of the County, with the boundaries of the study area being State Road No. 207 to the north, Interstate No. 95 to the west, State Road No. 206 to the south, and the Sebastian and Matanzas Rivers to the east.

The County has a total area of approximately 673 square miles, including about 60 square miles of open water. About 14 square miles of open water exists along the eastern side of the County in association with the Intracoastal Waterway. About 5 square miles are lakes, borrow pits, and streams. Another 41 square miles of open water occurs along the western side of the County within the St. Johns River.

About 362 square miles of the County drains westward towards the St. Johns River. Drainage from the roughly 16 square miles of land area in the general area of Palm Valley flows northward via the Intracoastal waterway and Pablo Creek to the St. Johns River. An estimated eight square miles of shoreline area, including 3.2 square miles in the Salt Run area (largely St. Augustine Beach), drains to the St. Augustine Inlet or the ocean, and about 231 square miles drain to the Tolomato or Matanzas rivers. Of the area draining to the Matanzas River, it is estimated that 15.8 square miles drains via Moses Creek and 41.7 square miles drains via Moultrie Creek.

Figure 1-1. Orientation Map



The Tolomato and Matanzas Rivers have been canalized to a maintained depth of 12 feet and width of 125 feet as part of the Intracoastal Waterway Federal project. The combined water area, marsh area, and associated minor drainageways directly associated with these two rivers within St. Johns County is estimated at about 71 square miles.

Essentially all of the 84 square miles of the Tolomato River drainage area and about 97 square miles of the 161 square mile drainage area of the Matanzas River discharge fresh water to the ocean through the St. Augustine Inlet. About 64 square miles of the Matanzas River watershed, essentially the area between Moses Creek and Pellicer Creek, can be expected to discharge to the Atlantic Ocean through the Matanzas Inlet. The mouth of Moses Creek is almost 6 miles from the Matanzas Inlet and about 11 miles from the St. Augustine Inlet. Fresh water discharges from Moses Creek can be expected to provide a greater influence to water quality conditions in the vicinity of the Matanzas Inlet.

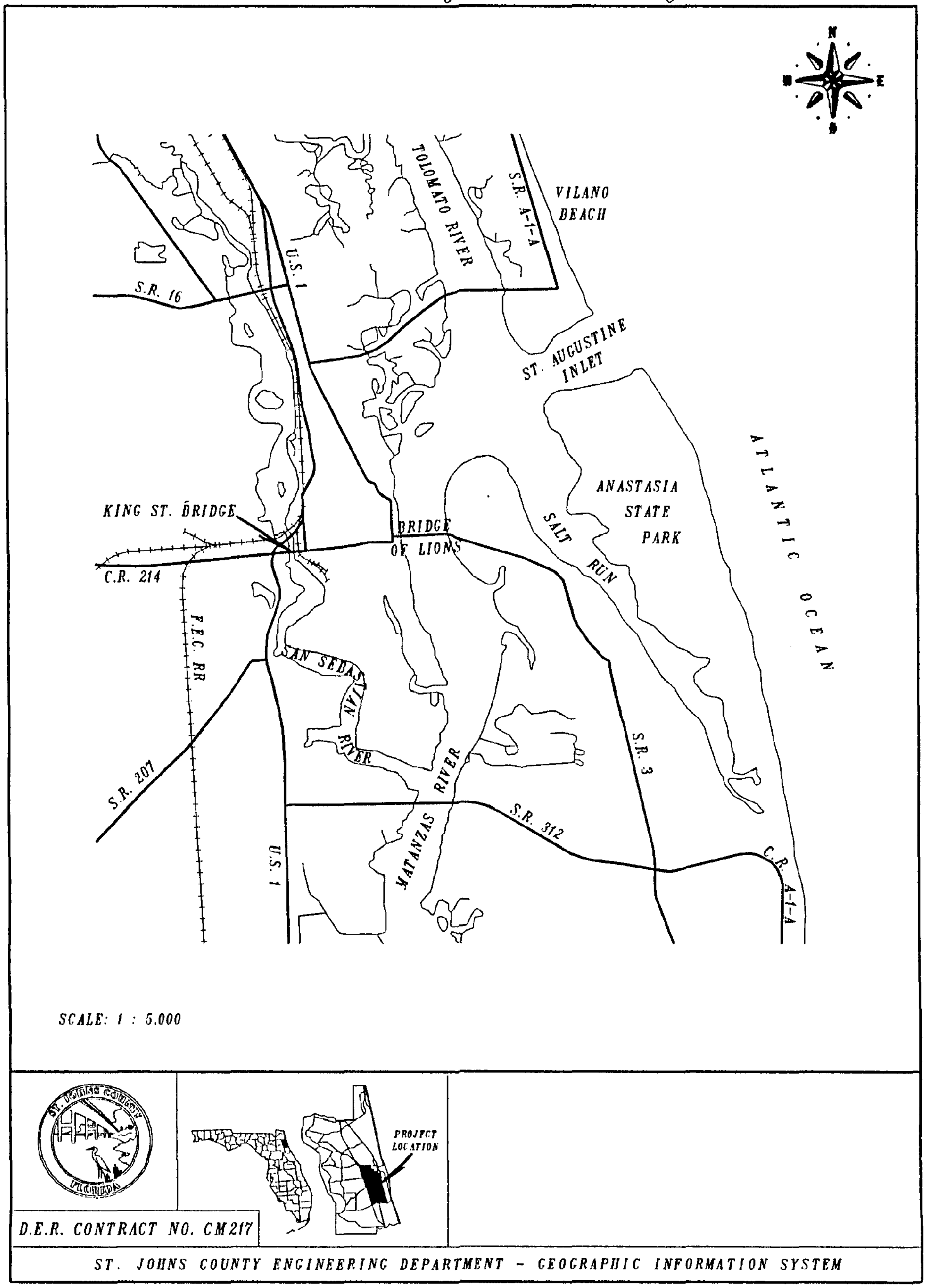
Moultrie Creek drains into the Matanzas River at a point about 5.8 miles south of the St. Augustine Inlet. Moultrie Creek is tidally influenced for a distance of about 5 miles upstream of its mouth and 3.4 miles upstream of the U.S. Highway #1 bridge. The southerly extent of reversing tidal influence and water exchange in the Matanzas River from the St. Augustine Inlet is unknown.

St. Augustine Harbor and Inlet

The St. Augustine Harbor was developed as a Federal project (**Figure 1-2. St. Augustine Harbor, FL**). The harbor consists of a stabilized channel 16 feet deep and 200 feet wide across the St. Augustine Inlet bar, then 12 feet deep to the Intracoastal Waterway, and a channel ten feet deep and 100 feet wide in the San Sebastian River from the Intracoastal Waterway to the Kings Street bridge. The St. Augustine Inlet was dredged across North Point (Vilano Beach) in 1940. It was initially known as the north entrance or new inlet. The original inlet was located at the southerly extent of Bird Island (now Conch Island) in what is now Anastasia State Park. Salt Run is the residual channelway to the original inlet.

Boat anchorages occur both to north and south of the Bridge of Lions in the Matanzas River. Salt Run also provides protected anchorages for boats. The mouth of the San Sebastian River is about 1.8 miles south of the Bridge of Lions. Most of the commercial terminals in St. Augustine are lo-

Figure 1-2. St. Augustine Harbor, FL.



cated along the lower 2.5 miles of the San Sebastian River.

Freshwater discharges from urban areas and activities associated with St. Augustine, St. Augustine Harbor, San Sebastian Creek, the lower Matanzas River and the Tolomato River are well mixed by the reversing tides moving through St. Augustine Inlet. Detailed studies would have to be conducted to estimate the extent of fresh water flushing that occurs through the inlet with each ebb or outgoing tide. Correspondingly, ocean water entering the harbor during flood or incoming tides can be expected to mix with the fresher waters within the harbor area and distribute these mixed waters upstream into the lower courses of the tributary streams, including Moultrie Creek.

The mixing process and redistribution of waters from the ocean and the several fresh water sources is ongoing with each tide reversal. The estuarine water quality throughout the area of influence of the tide reversal mixing process reflects the contributions of all sources of water within the system.

The water carried to the ocean through the St. Augustine Inlet is picked up and mixed with the ocean alongshore or littoral current. During the winter months of the year, this current or southerly drift moves water southward along the coastline. This movement is caused by wind generated swells produced by prevailing winds from the northeast. During the summer months, prevailing winds are from the southeast, and water from the St. Augustine Inlet becomes part of a northward littoral current. These alongshore currents are representative of the quality of ocean waters reaching St. Johns County shores.

Tide Ranges

The mean tide range through the St. Augustine Inlet is about 4.5 feet, and the mean spring tide range is about 5.3 feet. At the Bridge of Lions connecting the City of St. Augustine with Anastasia Island about two miles from the inlet, the mean tide range is about 4.2 feet.

The 1989 mean tide level at the Bridge of Lions was 0.38 feet above the National Geodetic Vertical Datum of 1929 (NGVD). NGVD is the national land leveling network upon which all land elevations in the United States are based. Based upon the tide range of 4.2 feet at the Bridge of Lions, the tide range at the mouth of Moultrie Creek is estimated at slightly less than four feet, and the elevation of mean high tide is about 2.3 feet above NGVD.

The highest tide on record at St. Augustine occurred during Hurricane Dora, September 10 and 11, 1964, when a high water elevation of twelve feet was recorded at the St. Augustine waterfront. An October 1944 hurricane that originated in the Caribbean, entered Florida near Sarasota on the west coast and crossed into the Atlantic Ocean near Jacksonville. This storm produced a hurricane tide of 7.9 feet NGVD at St. Augustine. The following return frequencies of storm surge related flood elevations have been established by the Federal Emergency Management Agency (FEMA) for national flood insurance purposes on the Matanzas River at the mouth of the San Sebastian River: 10 yr.—4.8 feet; 50 yr.—7.3 feet; 100 yr.—8.5 feet; and, 500 yr.—10.9 feet.

Federal Emergency Management Agency Flood Insurance Rate Map (FIRM) information for St. Johns County (Community No. 125147) (dated September 1985) established a 100 year return period flood elevation at the mouth of Moultrie Creek at 8 feet NGVD and the ten year return period flood elevation at about 4.5 feet. These flood elevations would be caused by storm tides.

Sea Level Rise

Throughout geologic history, global sea level variations (both rise and fall) have occurred. Some authorities have found evidence to indicate that we may be entering a new period of glacial advance with a resultant future drop in sea level. Others argue that increasing atmospheric concentrations of carbon dioxide and other gases are causing the earth to accelerate the warming trend of the current interglacial period. Accelerated warming would lead to further retreat of continental glaciers and a more rapid rise in sea level.

The national agency responsible for measuring sea level changes is the National Ocean Survey, a part of the National Geodetic Survey. From this agency's publication, Sea Level Variations for the United States 1855-1980 the trend of relative sea level change is on the order of a 1.9 mm rise in sea level per year. The National Research Council (NRC), whose members are drawn from the Councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine, has recommended that federal agencies should consider the high probability of future sea level rise. It may be some time before precise estimates of future sea level rise are possible. In the meantime, the risks associated with a substantial rise should not be disregarded.

The U. S. Army Corps of Engineers considers that at least twenty-five years of additional records will be needed to estimate local effective sea level rise rates with reasonable certainty and to reach some consensus on which of the various sea level rise scenarios is most likely. For now planning should consider what impact a higher relative sea level rise rate scenario would have on the design of projects based on the historical rate. The rate of change in sea level along the eastern Florida coast in the 1940 to 1980 time frame has been on the order of 2.4 mm per year. This rate of apparent sea level rise has been used for recent Corps of Engineers projects.

A rate of 1.9 mm per year would produce an apparent sea level rise of 3.7 inches in 50 years. A rate of 2.4 mm per year would produce a sea level rise of 4.7 inches in 50 years. The net effect of these conditions in the Moultrie Creek watershed would be the gradual movement of tidal conditions further upstream within the creek and its tributaries that discharge to tidewater. Ground water conditions also would be affected with an increased tendency for salt water intrusion to penetrate further inland from the Matanzas River and the tidewater part of Moultrie Creek.

WATERSHED LOCATIONAL SIGNIFICANCE

The Matanzas River, St. Augustine Harbor, and the St. Johns County shorelines immediately to the north and south of the St. Augustine Inlet are impacted by the volumes and qualities of the water discharged from the Moultrie Creek watershed. Moultrie Creek is one of numerous stormwater discharge sources to the area's estuarine receiving waters, and stormwater management practices would have to be applied to all discharge sources to significantly improve water quality conditions within these coastal receiving water areas.

2

CLIMATE AND RAINFALL

INTRODUCTION

An analysis of climate and rainfall serve as the basis for sound management of the watershed. The effect of frequent storm events, the associated periods of flooding, and protection of the surficial aquifer can be predicted with a greater understanding of climate and rainfall characteristics within the basin.

Hydrology deals with the properties, distribution, and circulation of water in the atmosphere, on the surface of the land, and in the soils and underlying rocks. The movement of water onto the land as rainfall, into the soils as infiltration, back to the atmosphere as direct evaporation and transpiration from plants, and as surface water runoff in streams is a process known as the hydrological cycle.

Current climatic conditions of northern Florida are heavily influenced by the large scale weather systems that move across the region. St. Johns County climate is also influenced by marine conditions and related weather events. The information provided in this report illustrates the dominant sources of rainfall to be expected within the County, general characteristics of rainfalls, and criteria for managing the resulting stormwater.

The source of water replenishing the Floridan aquifer underlying St. Johns County is the rainfall received in upland areas of north central Florida. Governmental actions taken by St. Johns County cannot control the replenishment of the Floridan aquifer.

Rainfall received in St. Johns County is the source of water that replenishes the surficial aquifer underlying the County. The primary source of potable water in St. Johns County, water used for human consumption, is the surficial aquifer. Protection of the surficial aquifer through management procedures assuring adequate recharge for public water supplies and private uses can be controlled by St. Johns

County. Similarly, actions of County government can reduce the effects of flooding due to rainfall events and provide protection for some significant natural resources within jurisdictional limits.

In this investigation, available hydrological information has been reviewed from the perspective of the need to provide for recharge to the surficial aquifer, reduce the effects of flooding, and provide protection to some significant natural resources through basin-wide stormwater management practices. Drainage of lands, as practiced in Florida until very recently, usually ignored the need to retain stormwater for aquifer recharge and natural resource area protection purposes. The protection of these resources requires some modification of local government infrastructural development and maintenance practices, changes in local governmental development review practices, and multiple purpose hydrological analyses and hydraulic designs for projects.

Hydrological information provide the basis of engineering design of all types of water control works. As a part of this project, a review was conducted of the ways in which hydrological information is conventionally used in local government development decisions. Some hydrological analysis criteria not generally considered in drainage design have been included in this report to provide preliminary guidance for protecting the aquifer and natural resources have those areas. Hydrological analyses methods and engineering evaluation procedures specifically oriented towards the design of water control facilities are referenced below.

A water management handbook will be prepared by the County as additional development guidance for property owners. Several publications are used for water management guidelines (see bibliography); however these documents do not adequately address aquifer and natural resource protection needs of St. Johns County. This deficiency frequently results in delays of local development approvals while County staff and permit applicants attempt to determine effective plans and practices in the absence of clear criteria and review procedures. In addition to County guidelines, the Handbook will incorporate or adapt pertinent engineering criteria for evaluations and methodologies developed by the St. Johns River Water Management District. <u>The Applicant's Handbook for Management and Storage of Surface Waters</u>, containing Water Management District guidance can be obtained directly from that agency. However, St. Johns County criteria, notably those criteria necessary for establishing stormwater retention facilities, will prevail in any development proposal review. Other useful sources of engineering design information are presented in the bibliography.

CLIMATIC FACTORS

Temperature Influences

Area temperature characteristics and seasonal changes in temperature reflect climatic conditions of the Floridan peninsula that contribute to an understanding of hydrological process dynamics. St. Johns County has a borderline subtropical climate with rare, short-duration freezing events affecting the area during the late December through February winter season.

Historical records for St. Augustine for the period 1902 through 1938 indicated an average January temperature of 58 degrees Fahrenheit with a lowest recorded temperature of 13 degrees. The July average temperature for that period was approximately 81 degrees with a maximum recorded temperature of 104 degrees. Temperature norms for the 1951 to 1980 period are 51.8 degrees for January and 79.9 degrees for July.

The study area generally is not subject to severe, long-duration freezes sufficient to affect road bases and building foundations, but exposed water pipes may freeze under occasional one to two day freezes during the movement of a severe winter frontal system through the area. The westerly part of the study area is subject to slightly cooler winter temperatures than typically occur within the areas close to the Matanzas River.

As normal winter conditions within the study area, ice occasionally has been found on standing shallow water areas near Tillman Ridge, but this occurrence is rare near the Matanzas River. Some damage to vegetation has occurred during severe freeze events, with more significant damage in the interior parts of the watershed. Similarly, frosts can occur on roofs during December through February period.

Winter temperatures are cool enough to give a pronounced seasonal character to plant growth. Winter cool weather is sufficient to terminate growth cycles of some plants, while many others become dormant. As a result, the removal of water from the surface soils by plant transpiration to the atmosphere decreases significantly during the winter months.

The eastern fringe of the Moultrie Creek watershed is influenced by microclimatic daily sea breeze conditions. Daily air exchange between the land and the ocean is noticeable inland to areas immediately west of Matanzas River. The effect diminishes in importance generally within one half mile inland from Matanzas River. Ocean influenced areas are cooled daily by air moving off the ocean during summer months and warmed daily by the ocean effect during winter months.

Storms

The daily sea breeze effect can be expected to result in very slightly reduced summer rainfall totals in St. Augustine and along the eastern edge of the watershed. St. Augustine rainfall is recorded at Radio Station WFOY located about one mile north of the U. S. Post Office and near the St. Augustine Inlet. This rainfall station is within the area influenced by the daily sea breeze effects. Sea breeze related storms providing rainfalls to land areas along the coast occur occasionally. During these storms, rainfall typically is more intense within one or two miles of the coast and diminishes in intensity towards the interior of the land area.

The familiar summer shower rainfall resulting from heated land surfaces and cooler air (differential heating and cooling and corresponding thunderstorms) occurs more frequently over inland parts of the County. This source of rainfall is typically provided by isolated storms passing along narrow bands or tracks with short-duration effects. These storms move with prevailing air currents as cells of thunderstorms typically one to three miles across. The highly localized rainfall can be intense, on the order of one to two inches during five to thirty minute periods. Part of the rainfall evaporates quickly due to summer temperature conditions. Sometimes, an intense rainfall from such storms produces short-duration ponded water on properties. If allowed to drain from the land, the water provided from these storms can be lost as runoff. While producing heavy, localized, and short-duration rainfall on small parts of the watershed. The common summer differential heating and cooling thunderstorms contribute only part of the area's warm season rainfall.

Rainfall occurs repeatedly on the watershed from midsummer through the winter months when high pressure systems with associated cold or cool fronts pass from west to east across the country and sometimes penetrate into Florida. In the summer months, most frontal systems move to the north of Florida, but these systems can penetrate southward into north Florida almost any month of the year. Strong high pressure systems passing to the north of Florida can generate persistent clockwise air movements resulting in winds from the northeast that move off the Atlantic Ocean and onto the eastern coastline of Florida. These are the northeasterly storms with winds of 20 or more miles per hour and with cloudy, drizzly weather lasting for several days. They can provide long-duration, low-intensity rainfalls across large areas. Several inches of rainfall over a two or three day period can be expected from northeasterly storms.

Heavy localized rainfall can occur when frontal systems move slowly across north Florida from north to south or northwest to southeast. The effects can become severe when the system stalls for an extended period over a part of the peninsula. As the cooler frontal system air comes into contact with the warmer, moister air over the Floridan peninsula, gentle, persistent rainfall occurs on the warm side of the front. Occasionally, a significant low-pressure trough develops across the peninsula on the southerly and warm side of the frontal system. As the frontal system stagnates or moves very slowly southward, very moist air can flow from the Gulf of Mexico and move across the peninsula providing rainfall along the low-pressure trough. The intensity of the low- pressure trough and its duration cannot be forecast easily, but these factors essentially determine the intensity of the rainfall associated with the event.

The above type of system was responsible for very heavy rainfall in parts of Jacksonville in August 1989 and again in late September 1989. Recorded rainfall in the second event in Jacksonville reached the expected 100-year return frequency rainfall of over 11 inches in twenty-four hours in the downtown and northwest parts of the city. Much of the city (Duval County) received in excess of 4 and 5 inches of rainfall. Comparable conditions have been responsible for major flooding events across much of the state of Florida over the years.

The September 1989 system that affected northeast Florida provides a useful example of the character of the rainfall incidence to be expected under this weather condition. The warm, moist air channeled towards the northeast from the Gulf of Mexico was concentrated in a series of cells with thunderstorm characteristics moving in bands across the peninsula. The rainfall from specific cells was intense, and the cells deposited differing amounts of rainfall on the areas over which they passed. At the same time, only a relatively small part of Jacksonville experienced an extremely heavy rainfall that might be expected on an average of once in one hundred years.

The trough also produced the heaviest rainfall in a relatively narrow band. In northeast Florida, Baker, Duval, and Nassau counties received very heavy rainfall, while Clay County received a lesser amount of total rain, and St. Johns and Putnam counties received rainfall amounts that could be expected annually from frontal weather systems.

Another more typical frontal system moved southward through St. Johns County on October 8, 1989. The day started with clear skies, but clouds became dominant by midday. The rainfall began in early afternoon and ended in the early evening hours. On that day, radio station WFOY in St. Augustine recorded a rainfall of 1.09 inches. Conditions became atypical when the front stalled over central Florida setting up unstable atmospheric conditions. A low pressure trough formed above the unstable frontal system setting up a movement of moist Gulf air from the southwest. At the same time, frontal systems passing to the east and north of Florida set up a northeasterly air movement from the Atlantic Ocean. The air moving from the northeast and the cooler Atlantic Ocean and the warm, moist air moving from the southwest and the Gulf of Mexico set up bands of rainfall that became intense along the coastline between St. Augustine and Melborne. The combination of moisture laden warm and cool air resulted in the 11.28 inch daily rainfall recorded at radio station WFOY on October 10, 1989. However, a rainfall of 16 inches was recorded at the Emergency Management Center in St. Augustine on October 10. The official National Weather Service (NWS) four day rainfall recorded at radio station WFOY in St. Augustine between October 8 and 11 was 12.45 inches.

A significant part of the late summer, fall, winter, and spring rainfall in northeast Florida is provided by, or in association with, cold fronts passing southward along the Floridan peninsula. Review of storm data records suggest that frontal system rainfall, including northeasterly storms, produce the more significant part of the total annual rainfall received on most of the Floridan peninsula.

Another important source of rainfall is associated with the passage of tropical low-pressure systems across the peninsula. Beginning in the 1980's, the National Hurricane Center in Coral Gables, Florida, has been reporting the movement of tropical low-pressure systems that move from east to west across the Atlantic Ocean and pass over the Floridan peninsula.

On the order of 50 or more of tropical or easterly waves form each year and move to the west across the Atlantic Ocean at latitudes of between 10 to 20 degrees. Some form into low-pressure depressions or troughs that can produce significant rainfall, typically across the southeast part of the peninsula. Some of these systems extend northward far enough to produce heavy rainfall along the northeast Florida coastline.

When the tropical system becomes organized enough to generate a circulating wind pattern with sustained wind speeds of more than 39 miles per hour, it is classified as a tropical storm. Tropical storms can produce significant rainfall over thousands of square miles of the earth's surface in their paths. In August 1981 Tropical Storm Dennis deposited over 20 inches of rainfall in a twenty-four hour period near Homestead, Florida, and relatively widespread rainfall across much of southeastern Florida. The storm took a track northward through southeastern Florida and back into the Atlantic Ocean near Fort Pierce. On August 19, Tropical Storm Dennis passed to the east of St. Augustine and northern Florida. Over the 6 day period from August 16 to August 21, St. Augustine received 2.35 inches of rainfall from the disturbed atmospheric conditions associated with this tropical storm.

When the circulating wind speeds of tropical storms reach sustained velocities of 74 miles per hour, they are reclassified as hurricanes. These storms are very rare, and only a few have produced damaging effects in northeast Florida. However, northeast Florida can receive rainfall from the bands of circulating winds and associated cells of thunderstorms moving around a hurricane hundreds of miles from its center. In 1985 Hurricane Elena moved from the Caribbean Ocean into the Gulf of Mexico and stagnated for almost two days about 75 miles southwest of Cedar Key on Florida's west coast. For several days, outer bands of that storm passed across northeast Florida producing significant rainfall amounts. During the two days of August 31 and September 1, when Elena was offshore of Cedar Key, St. Augustine recorded rainfalls totaling 4.09 inches. Any hurricane passing within roughly two hundred miles of northeast Florida can be expected to provide some rainfall for local areas.

The rainfall received in northeast Florida and the study area is largely dependent upon weather conditions that cannot be predicted on any long-term basis. Much of the annual rainfall received occurs as a result of large storm systems that move across the Floridan peninsula. The amount of rainfall that is produced by any specific weather system is also essentially unpredictable. Presently, it is not possible to know with any degree of certainty how much rainfall is going to fall daily, weekly, monthly, or annually on the Moultrie Creek watershed or any other ground water recharge area in Florida.

PRECIPITATION

Rainfall Records

St. Johns County rainfall is recorded by the National Weather Service as part of the north Florida Climatic Division comprised of 20 counties. The normal annual rainfall for the Division based upon the 1951–1980 period is 53.61 inches. The normal annual rainfall for the Division based upon the 1931–1960 period was 52.65 inches. Normal annual rainfalls based upon the 1951–1980 period were available for Federal Point, in St. Johns County near the mouth of Deep Creek, (52.84 inches), St. Augustine (52.6 inches), and Jacksonville Beach (50.35 inches). From these data, an expected annual rainfall of 53 inches would be generally representative of conditions in the Moultrie Creek watershed.

Monthly rainfall records for several stations in the vicinity of St. Augustine dating from 1877 to 1984 were available for this study. The National Weather Service has compiled composite information for these stations useful for estimating general rainfall conditions for the St. Augustine locality. These data are also generally representative of the rainfall to be expected on the easterly portions of the Moultrie Creek watershed.

The composite rainfall records for St. Augustine show a variation in the annual rainfall ranging between 29.2 (1956) and 79.5 (1953) inches, with a long-term (1917–1984) average annual rainfall of 50.7 inches. No real pattern exists to establish a trend in annual rainfall variation. In illustration, the five years with the highest annual rainfall and the five years in the record with lowest annual rainfall are presented in **TABLE 2-1. ANNUAL RAINFALL EXTREMES ST. AUGUSTINE, FLORIDA.**

The National Weather Service has produced an atlas of monthly Palmer hydrological drought indices for the contiguous United States. The Palmer drought index data for the North Florida Climatic Division was reviewed to determine the duration of periods in the rainfall record with below average rainfall and those periods with above average rainfall. Drought Index information was available for the 1,032 month period between 1898 and 1984.

The data indicated that about 5.2 percent of the record period (54 months) had extended drought conditions, with evapotranspiration exceeding rainfall on an average for three or

TABLE 2-1

ANNUAL RAINFALL EXTREMES
ST. AUGUSTINE, FLORIDA
(Record Period 1877 to 1984)

5 Years With Greatest Total Annual Rainfall			5 Years With Least Total Annual Rainfall		
Rank	Year	Amount (Inches)	Rank	Year	Amount (Inches)
1	1953	79.91	1	1956	29.20
2	1964	79.50	2	1911	31.59
3	1972	73.61	3	1954	34.14
4	1942	71.84	4	1927	34.41
5	1880	67.34	5	1917	34.79

more months. The most significant drought period affecting the Moultrie Creek watershed extended for 16 months between November 1955 and February 1957. Recorded monthly rainfall for this period at St. Augustine was 32.69 inches, or 54.7 percent of the normal rainfall.

Extended wet periods represented 3.1 percent of the record time frame. The longest extended wet period for the North Florida Climatic Division extended for 8 months between October 1947 and May 1948. In the time frame between September 1947 and March 1948, monthly rainfall at St. Augustine exceeded the normal of 29.23 inches for those months by 37 percent.

The above data were presented to illustrate the likely range of extended period rainfall variability which should be expected in the Moultrie Creek watershed. Extended periods of drought and above normal rainfalls can be expected at any time in the future. Lack of rainfall for extended periods is particularly significant in St. Johns County where the surficial aquifer is used heavily for potable water supplies.

The extended wet periods also provide information useful for stormwater management planning. The large areas of flatwood soils within the Moultrie Creek watershed have normal high water tables during the winter months of the year. Extended wet periods can be expected to result in saturated soils and shallow flooding within high natural water table areas during these prolonged wet periods. Consideration of wet season water table conditions should be incorporated into revisions of water management framework. Of special concern are the public health and safety needs of people living in developments permitted in areas where water tables are naturally higher and where shallow flooding is a highly probable natural occurrence.

Average Daily Rainfall

The available hourly and daily data for rainfall stations in St. Johns County were reviewed to develop basic information on the number of rainfall events to expect annually and the amounts of average daily rainfall to expect during individual events. Hourly precipitation data were not available for any station that might be representative of the Moultrie Creek watershed. All stations reviewed had missing data, but the Hastings rainfall station had a continuous record of daily rainfall amounts for the period from January 1978 to December 1986, a 9 year period. The Hastings rainfall gage is located at the Agricultural Center about 10.5 miles southwest of I-95 and State Road 207 and the southwesterly part of the Moultrie Creek watershed.

The total rainfall record period reviewed for Hastings consisted of 3287 days. During the record period, some rain fell on 1041 days, or 30.7 percent of the days in the period. However, 388 of the days with rainfall had total amounts of less than 0.1 inches, and this rainfall represented only 3.1 percent of the total received at Hastings during the 9 year period. Daily rainfalls of 0.1 inches approximate the amount of water lost each day to evapotranspiration and do not effectively contribute to ground water recharge.

No intense nor prolonged periods of extreme rainfall were recorded. The maximum daily rainfall recorded for the period was 4.68 inches. All of the maximum daily rainfalls can be accounted for in the context of normal events to be expected annually or on a two year expected return frequency basis. No attempt was made to separate the data into rainfall events. Daily records do not permit the identification of storms that begin on one day and end one or more days later.

Review of the daily data identified numerous periods during fall, winter, and spring months when no rainfall was recorded for ten and more days. One time frame of 26 days with no rainfall occurred during the record period. Some rainfall occurred on about 31 percent of the total days in the period, but daily rainfalls of more than 0.1 inches occurred on only 653 days, about 20 percent of the total days in the 9 year period. Distributing the 653 rainfalls evenly throughout the total period would reflect one day with rainfall of more than 0.1 inches on an average of about once every five days.

The daily rainfall recorded at Hastings during the 9 year period is summarized in **TABLE 2-2. DAYS WITH RAINFALL HASTINGS, FLORIDA,** and **TABLE 2-3. AVERAGES OF DAILY RAINFALL AMOUNTS HASTINGS, FLORIDA.** Table 2-2 describes the general distribution of days with rainfall grouped by categories of rainfall amounts recorded. This table illustrates the rare condition of daily rainfalls with more than two inches. The data identified only 32 days in the nine year period with daily rainfalls of more than two inches; a frequency of 3.5 days per year with rainfalls exceeding two inches.

Table 2-3 summarizes the average rainfall received each year by categories of rainfall amounts. The average annual rainfall at Hastings is 53.9 inches. The first 0.5 inches of every rainfall amounts to an average annual total of 29.5 inches. If the first 0.5 inches of all rainfalls are retained or stored and allowed to infiltrate into the ground as water table recharge, about 55 percent of the annual rainfall would become available for this purpose. Retention of the first 1.0 inch of every rainfall would mean that no runoff would be allowed for rainfalls of less than 1.0 inches. Under this condition, almost 78 percent of the average annual rainfall would become available for recharge. Retention of the first 2.0 inches of every rainfall would represent the potential storage of almost 92 percent of all normal annual rainfall amounts.

TABLE 2-2

DAYS WITH RAINFALL
HASTINGS, FLORIDA (Station No. 3874)
January 1978 to December 1986

Daily Rainfall (Inches)	Number of Rainfall Days	Percent of Total Rainfall Days	Percent of 3287 Days in Period
0.0 – 0.1	388	37.3	11.8
0.1 – 0.49	353	33.9	10.7
0.5 – 0.99	155	14.9	4.7
1.0 – 1.99	113	10.8	3.4
2.0>	32	3.1	0.1
Total	1041	100.0	30.7

TABLE 2-3

AVERAGES OF DAILY RAINFALL AMOUNTS
HASTINGS, FLORIDA (Station No. 3874)
January 1978 to December 1986

Daily Rainfall (Inches)	Average Rainfall Per Year Inches	Annual Average of First 0.5 Inches	Annual Average of First 1.0 Inches	Annual Average of First 2.0 Inches
0.0 – 0.1	1.7	1.7	1.7	1.7
0.1 – 0.49	10.5	10.5	10.5	10.5
0.5 – 0.99	13.6	8.6	13.6	13.6
1.0 – 1.99	16.6	6.3	12.6	16.6
2.0>	11.5	2.4	3.6	7.1
Annual	53.9	29.5	42.0	49.5

Daily rainfalls greater than 2.0 inches represented 4.4 inches of the annual average rainfall.

Until further studies of rainfall characteristics are undertaken for a larger number of stations, the above data can be used to estimate annual rainfall characteristics to be expected in interior St. Johns County. Standard urban area drainage systems are sized to provide for the removal of excess stormwater from rainfall events with total amounts greater than reflected in the above data. Runoff from a 25 year 24 hour rainfall is sometimes used to establish the maximum capacity of a drainage system. Unless the stormwater systems are also designed to detain or retain the routine daily rainfall amounts expected on an annual basis, overdrainage and associated long-term local ground water deficiency problems can occur.

Expected Rainfall Return Periods

Economic and engineering evaluations of water management measures and facilities requires information on the expected likelihood (return period) of rainfalls of some frequency and duration. Cooperation between the U. S. Weather Bureau and the U. S. Department of Agriculture, Soil Conservation Service, began in 1955 for the purpose of defining the depth-area-duration frequencies of rainfall in the United States. These efforts resulted in the Rainfall Frequency Atlas of the United States, Technical Paper No. 40, published in May 1961. This document provided generalized information for rainfall with durations from 30 minutes to 24 hours and return periods from 1 to 100 years.

A second technical paper was produced by the Weather Bureau in 1964 (Technical Paper No. 49). This document provided generalized information for two– to ten–day precipitation for return periods of 2 to 100 years in the contiguous United States. This document was an extension of the work published in Technical Paper No. 40. A final document was published in June 1977 that provided five– to 60–minute precipitation frequency information for the eastern and Central United States(NWS HYDRO–35). The latest document provides guidance specifically for the hydrological planning and design for small area drainage areas.

The map and technical information from the above three documents has been assembled to represent probable rainfall return conditions in St. Johns County. The data derived from the above sources is provided in **TABLE 2-4. PROBABLE RETURN FREQUENCIES OF PRECIPITATION AMOUNTS ST. JOHNS COUNTY, FLORIDA.**

As part of the Weather Bureau's initial study effort, a statistical probability analysis was conducted to establish the degree that data for a rainfall station represents rainfall on adjacent areas. Results from this part of the Weather Bureau's evaluations indicate the following: 95 percent of 24 hour rainfall data recorded at a location would be applicable to an adjacent 50 square mile watershed and about 92 percent of the rainfall data would be applicable to a 400 square mile watershed. These findings suggest that the daily rainfall recorded at St. Augustine or Hastings would be generally representative of rainfall occurring on the Moultrie Creek watershed.

The Weather Bureau's findings also indicate that as the duration of the rainfall event decreases, the rainfall station data are applicable to smaller areas. For example, only about 70 percent of a 30 minute rainfall recorded at a station would be expected to directly apply to a nearby 50 square mile watershed. This concept reflects the condition that localized rainfall systems affecting small areas tend to be associated with short–duration rainfalls. As a result of these limitations and as an example, it would not be appropriate to directly apply hourly rainfall data from the Hastings rainfall station with rainfall and subsequent conditions occurring on the Moultrie Creek watershed, but daily rainfall data would generally remain applicable.

TABLE 2-4
PROBABLE RETURN FREQUENCIES OF PRECIPITATION AMOUNTS
ST. JOHNS COUNTY, FLORIDA
(PRECIPITATION IN INCHES)

RAINFALL DURATION (Minutes)	RETURN PERIOD (years) 2	5	10	25	50	100
5	0.57	0.62	0.66	0.74	0.79	0.85
10	0.97	1.09	1.18	1.33	1.44	1.56
15	1.25	1.41	1.54	1.74	1.89	2.10
30	1.72	2.07	2.33	2.71	3.00	3.30
(Hours)						
1	2.2	2.6	3.0	3.4	3.8	4.2
2	2.7	3.5	3.9	4.5	4.8	5.4
3	3.0	3.9	4.2	5.0	5.5	6.0
6	3.6	4.5	5.3	6.0	6.8	7.3
12	4.4	5.5	6.5	7.2	8.2	9.0
24	5.0	6.5	7.6	8.8	10.0	11.0
(Days)						
2	5.5	7.3	8.3	10.0	12.0	12.8
4	6.3	8.2	10.0	12.1	13.8	14.6
7	7.5	9.3	10.6	12.7	14.5	16.2
10	8.2	10.4	12.4	14.5	16.2	18.0

Probable maximum 6 hour rainfall (PMP) for 10 square miles is about 31 inches in northeast Florida. The main purpose of the PMP value is to provide complete-safety design criteria in cases where a water control structure failure would be disastrous.

SOURCES: Values for rainfall durations in minutes were derived from: Ralph H. Frederick, et. al., FIVE- TO 60- MINUTE PRECIPITATION FREQUENCY FOR THE EASTERN AND CENTRAL UNITED STATES, NOAA Technical Memorandum NWS HYDRO-35, Office of Hydrology, National Weather Service (NWS), National Oceanic and Atmospheric Administration (NOAA), Silver Springs, Md., June 1977. Values for rainfall durations in hours were derived from: David M. Hershfield, RAINFALL FREQUENCY ATLAS OF THE UNITED STATES For Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years,Technical Paper No. 40, Weather Bureau (now the NWS of NOAA), U. S. Department of Commerce, Washington, D. C., May 1961. Values for rainfall durations in days were derived from: John F. Miller, Two- to Ten-Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States, Weather Bureau, U. S. Department of Commerce, Washington, D. C., 1964.

3

GEOLOGY AND LANDFORMS

GEOLOGY

Upper Surficial Sediments

The upper 50 to 60 feet of materials underlying St. Johns County and the Moultrie Creek watershed is comprised of sands, shells or coquina, and small amounts of clay. These materials apparently were deposited during the warm interglacial periods when sea levels were considerably higher than current conditions. Following successive depositions, several periods of erosion and redeposition apparently occurred. This process gradually shaped the surface materials to produce the characteristics of landforms currently found within the County.

Geologists have traced a series of continental glacial advances and retreats over the past one to two million years which they identify as the Pleistocene Epoch. Scientists generally consider that the Pleistocene Epoch ended about 10,000 years ago, and we are living within a geological period known as the Recent or Holocene age.

The maximum penetration of the last major glacial advance on the North American Continent is now considered to have occurred about 18,000 years ago. Geologists have estimated that ocean levels were over 100 feet lower than present sea level during the height of this glacial period.

A gradual worldwide rise of ocean levels has been occurring since the last retreat of the continental glaciers. The last continental glacier receded from the United States part of North America about 7,000 to 9,000 years ago. As a result of studies conducted near Miami in Biscayne Bay scientists have concluded that sea level was about six feet below current ocean levels approximately 6,000 years before the present. We are now living in a geological age with current climate and sea level conditions reflecting an interglacial period in the geological history of the earth.

At least four Pleistocene interglacial ages appear to have significance relative to surficial sediments in St. Johns County. An interglacial period labeled the Penholoway Age produced remnant terraces in Florida at an altitude of about 70 feet. During this age, probably all of St. Johns County was an offshore bar of an ancient ocean shoreline.

The second interglacial period has been termed the Talbot Age which resulted in sea cut terraces on the Floridan peninsula at an altitude of about 40 feet. During this interglacial period, the Tillman Ridge apparently was a shallow shoal and island area with sand dunes rising at least ten feet above sea level. The Moultrie Creek watershed area would have been a gently sloping beach and foreshore area.

The third interglacial period has been named the Pamlico age when terraces were cut at an elevation of about 25 feet above current sea level. Recent scientific studies conducted on coral reef terraces in the Barbados Islands and in New Guinea have determined that the world's oceans were at an elevation of about 20 feet above the current level approximately 125,000 years ago.

Finally, poorly defined Silver Bluff terrace remnants exist around the Floridan peninsula at elevations of between five and ten feet above current sea level. The Talbot and Silver Bluff interglacial periods could be expected to have produced the final shaping of the lower landforms in St. Johns County. From these periods to the present, stormwater runoff gradually cut Moultrie Creek and its tributary streams into the low plateau that is now the Moultrie Creek watershed.

Lower Sediment Deposits

Beneath the Moultrie Creek watershed, the upper 50 to 60 feet of sediments are underlain by more dense, less permeable sand, shells, sandy clay, and clay about 25 to 50 feet in thickness. These materials rest upon the blue to green clay materials of the Hawthorn Formation. The Hawthorn Formation forms an aquiclude (an impermeable layer) or aquitard (an area of low permeability) that separates the materials identified with the St. Johns County surficial aquifer from the limestone formations associated with the Floridan aquifer.

Limestone Formations

The top of the limestone formations beneath the Moultrie Creek watershed is generally found about 200 feet beneath land surface. South of the Moultrie Creek watershed the top of the limestone occurs about 150 feet beneath land surface. The several rock formations extending to about 350 feet beneath land surface are now collectively called the Ocala Group. These formations are the primary and more productive artesian water supply sources associated with the Floridan aquifer.

LIMESTONE FORMATIONS

General

The top of the limestone formations underlying north central Florida and St. Johns County slope generally from southwest to northeast. In central Alachua County and western Marion County, the top of the Floridan aquifer is found 50 to 75 feet above mean sea level. The top of the limestone formations in this central Florida area is directly overlain by a zone of permeable silica sands. This sand zone has been identified as a secondary artesian aquifer in St. Johns County.

The Hawthorn Formation that functions as an aquiclude or aquitard (preventing or retarding the upward or downward movement of water) is missing from the central Florida uplands of western Clay and Putnam counties, and most of Alachua and Marion counties. Additionally, substantial solutioning has occurred within the limestone formations, resulting in sinkhole formations where the limestone is near the land surface. Where sufficient surface material debris has partially plugged the exposed drainage points within sinkholes, surface water ponding has occurred.

In the Moultrie Creek study area, the top of the Floridan aquifer is generally found at elevations of 175 to 200 feet below mean sea level. Along the St. Johns County coast, the top of the Floridan aquifer in the vicinity of Pellicer Creek, at the south boundary of the County, is about 150 feet below mean sea level. In the Ponte Vedra area on the north, it occurs more than 350 feet below mean sea level.

Water Supply Aquifers

Floridan Aquifer

Rainwater falling on Clay, Alachua, and other interior counties infiltrates into the surface sands or runs off directly into sinkholes. These localities are considered as primary Floridan aquifer recharge areas that establish the water pressure head for fresh water withdrawn from the limestone formations beneath St. Johns County. Rainwater enters the limestone aquifer through permeable materials in areas where local water tables are at elevations higher than the water pressure head within the aquifer. The rainwater entering the Floridan aquifer moves by gravity through solution channels in the limestone, along seams between the rock layers known by geologists as bedding planes, and through the rock materials. Where the Floridan aquifer is overlain by impermeable materials, the pressure exerted by the weight of the water within and above the aquifer causes increased movement of water through the aquifer.

Some of the ground water flow entering the Floridan aquifer emerges as seepage back to the land surface at elevations below the points where the rainfall infiltrates into the ground. Part of the flow of streams flowing eastward from Central Florida (The Oklawaha River, Rice Creek, and Black Creek) is the result of reemerging Floridan aquifer water. Ground water that seeps back to the land surface and becomes part of the flow of streams is known by hydrologists as base flow.

The Hawthorn Formation overlies the limestone formations westward from the Atlantic coast through western Putnam, Clay, and Baker counties. This formation traps the ground water in the Floridan aquifer,forcing it to flow eastward towards the Atlantic Ocean. As a result, wells penetrating into the Floridan aquifer in eastern St. Johns County have in the past been known to rise in the wells to heights approximating 20 feet above sea level. Aquifers with these conditions are known as artesian aquifers. Because land elevations in the Moultrie Creek watershed are generally at altitudes higher than 20 feet above sea level, artesian flow to the land surface does not occur.

The potential height to which artesian water rises in a tightly contained well is known as the potentiometric head for that well. The generalized potentiometric levels for wells within a region are known as the potentiometric surface for that regional area.

Within the Moultrie Creek watershed, Floridan aquifer waters occur beneath the Hawthorn Formation. Wells drilled to depths of 150 or more feet generally will obtain Floridan aquifer water. Due to the water pressure in the aquifer, some seepage upward, termed leakance by hydrogeologists, into, and perhaps through, the Hawthorn Formation can be expected. The extent of this upward leakance into the sands above the Hawthorn Formation has not been investigated.

The quantities of Floridan aquifer water available in eastern St. Johns County is substantial, though not unlimited. Declines in the potentiometric levels of the Floridan aquifer throughout northeast Florida have been widely reported since the 1950's. These declines generally reflect water withdrawals in excess of the ability of rainfall in recharge areas to replenish the aquifer.

Investigations of 85 irrigation wells in western St. Johns County determined that the upper 50 feet of the aquifer provided most of the water flow zones. About 50 percent of the wells tested produced water with chloride (salts) contents of less than 210 parts per million (ppm). Wells penetrating deeper into the aquifer tended to produce water with higher chloride concentrations. Some wells penetrating deeper aquifer zones produced water that exceeded 3,000 ppm. As withdrawal in the upper aquifer zones were increased, water with higher chloride contents were drawn upward, contaminating the fresher upper water zones.

While the Floridan aquifer is available as a ground water supply source in eastern St. Johns County, the water is high in chlorides and other minerals. The U. S. Environmental Protection Agency (EPA) and the Florida Department of Environmental Regulation have established potable water limits for chlorides at 250 milligrams per liter (mg/l) or 250 parts per million. Water high in chloride content is very corrosive to metals, harmful to most cultivated plants, and unpleasant to drink. A concentration of about 400 ppm can be tasted by most people.

North of the Moultrie Creek watershed, the Ocala Group of the Floridan aquifer generally produces water with chloride concentrations of less than 250 mg/l. Beneath the Moultrie Creek watershed, the chloride content of the upper limestone formations of Floridan aquifer water is at or greater than 250 mg/l. Towards the south, the chloride content of Floridan aquifer upper water bearing zones increases to 1,000 mg/l near the Flagler County line. Throughout St. Johns County, the lower limestone formations of the Florida aquifer typically produce water with chloride concentrations of 250 mg/l or more.

Surficial Aquifer

The surficial aquifer within the Moultrie Creek watershed is a composite of confined and unconfined water-bearing zones comprised of the sands, shells, and coquina occurring above the Hawthorn Formation. Most wells used for potable water supplies in the study area are drilled to depths of the less than 100 feet below sea level. Some water is obtained from wells penetrating sand and shell strata within the Hawthorn Formation. The water from wells open to the surficial aquifer generally meets quality standards recommended for public water supplies, except for concentrations of iron. The iron content of water from most of the wells tested during a study by the United States Geological Survey (USGS) conducted in east-central St. Johns County was well above the recommended limit of 0.3 mg/l. High iron contents of water are undesirable because of the taste it imparts and the staining effect it has on clothes, faucets and associated fixtures, painted walls, and natural stone. Iron from water can be removed at water treatment plants by aeration or filtration.

The surficial aquifer in the Moultrie Creek watershed is replenished primarily from direct rain water. Recharge to the surficial aquifer can only occur when rain water is retained long enough to infiltrate the surface sands and slowly percolate downward to the water table.

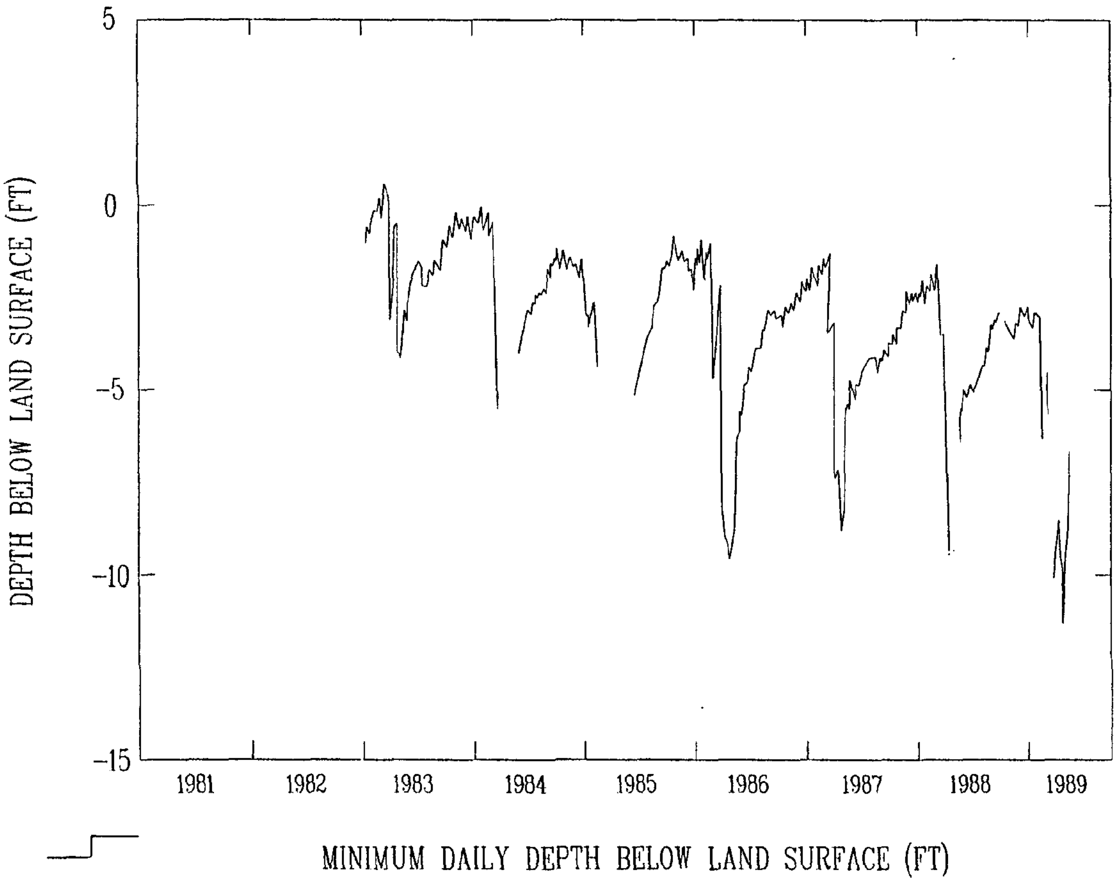
The surficial aquifer is widely used by individual property owners for potable and other uses. It was formerly used exclusively by the City of St. Augustine, but current demands exceed the capacity of the city's surficial aquifer well field yield capacity.

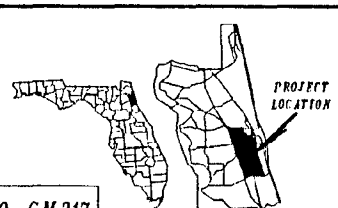
St. Augustine and St. Johns County have surficial aquifer well fields located along or near Tillman Ridge on the western side of the Moultrie Creek watershed. U. S. Geological Survey records of two monitoring wells in the Tillman Ridge area have detected a progressive decline in the water table in the vicinity of these well fields (**Figure 3-1. USGS Well SJ 112E Tillman Ridge.**) These data suggest that long term withdrawals for public water supplies are currently exceeding the natural rain water recharge in the areas of the well fields.

The City of St. Augustine has begun the process of augmenting surficial aquifer water with the saltier water from the Floridan aquifer. This is a temporary measure that will require further surficial aquifer well field expansion as public demand for potable water provided by St. Augustine increases.

Correspondingly, St. Johns County can be expected to be required to supply potable water to increasing numbers of County residents in the near future. The rural practice of using individual surficial aquifer wells for potable water in the same locations where septic tank waste disposal is per-

Figure 3-1. USGS Well SJ 112E Tillman Ridge





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ST. JOHNS COUNTY ENGINEERING DEPARTMENT - GEOGRAPHIC INFORMATION SYSTEM mitted can be expected to lead to increased County public health problems as County areas urbanize.

Stormwater Management Implications

As increased amounts of surficial aquifer water beneath the Moultrie Creek watershed becomes used by St. Augustine and St. Johns County for public water supplies, further declines in local water table conditions can be expected. Trestle Swamp, Cowan Swamp, and other upland natural areas will have longer and longer periods when the water table will be below the land surface. The weight of the water retained in the surficial aquifer acts against the upward leakance potential of the Floridan aquifer. As the water table declines, corresponding upward movement of Floridan aquifer waters into and, to some extent, through parts of the Hawthorn Formation could be expected to occur.

In areas of the watershed where septic tanks are used for sewage disposal, septic tank effluents are significant sources of water recharge to the surficial aquifer. Maximizing rainfall retention in these areas, as opposed to primary dependence upon uncontrolled stormwater drainage, would serve to increase recharge to the surficial aquifer and provide a means for diluting septic tank effluents introduced into the surficial aquifer.

A perspective of the ground water recharge significance of septic tank effluents can be obtained by the following example analysis. Assume a family of four living in a home on a one quarter acre lot. Each person uses an average of 100 gallons of water per day which is discharged to the septic tank. This is an approximate average water usage for urban populations using public water supplies. The total family daily water usage is then 400 gallons, or about 53.4 cubic feet per day. The family's property, at one fourth acre, is 10,890 square feet. If the 53.4 cubic feet per day were discharged to a septic tank and the resultant effluent was distributed across the 10,890 square foot lot, the effluent would be roughly equivalent to rainfall infiltration into the soil approximating 0.06 inches every day, 365 days of the year. In the event that the above amount of water was discharged into a septic tank, the effluent could be equivalent to the infiltration into the ground of about 20 inches per year from rainfall.

Later information in this study shows that the Moultrie Creek watershed, on the average, receives about 53 inches per year from rainfall, and about 30 percent of any significant rainfall is directly discharged to streams as runoff within 4 days following the rainfall event. At best, about 37 inches of the area's rainfall may infiltrate into the ground, but roughly 20 percent of that amount reemerges as base flow within three weeks following a rain event.

LANDFORMS

The Moultrie Creek watershed is a nearly flat to gradually sloping plateau generally raised 30 to 45 feet above existing sea level. The easterly side of the plateau at the Matanzas River generally has land elevations exceeding 20 feet. Land elevations exceeding 40 feet still exist at isolated locations along U.S. Highway #1 north of Moultrie Creek. The westerly side of the Moultrie Creek watershed forms a surface water drainage divide between runoff draining to the Matanzas River and runoff draining westward to the St. Johns River. The Tillman Ridge, which forms the drainage divide, is paralleled by Interstate Highway #95 located about 1 mile to the east as shown in Figure 1-1. The Tillman Ridge is a gradually sloping upland with general land elevations of 40 to 48 feet.

The landforms of the Moultrie Creek watershed and all of St. Johns County were formed in association with shorelines to ancient seas. Geologists consider the study areas's landforms as a terrace system formed during previous interglacial times when ocean levels were 25 to 40 feet above present sea level. The Tillman Ridge is geologically associated with the Atlantic Coastal Ridge that extends for most of the length of the Floridan peninsula. What is now the Moultrie Creek watershed was once a very gradually sloping shoreline related formation, possibly an offshore bar.

Wave action along shorelines produces slight wave cut troughs just offshore of beach fronts, with the disturbed sands redeposited as low ridges or bars some distance offshore. As ocean water elevations become lowered, the former beach sand dunes become sand ridges and the former offshore bars become slightly lower ridge line areas.

Immediately east of the Tillman Ridge is a large, parallel depressional area known as the Trestle Bay Swamp. The bottom elevation of this swamp is at or above 35 feet. About one mile to the east is another parallel depressional area known locally as the Cowan Swamp. Between State Roads 16 and 214, the bottom of the Cowan Swamp is above 30 feet in elevation. Near State Road 214 the beginning of the Moultrie Creek channel begins with a channel flow direction towards the south and generally aligned according to the ancient shoreline trough to tidewater.

The fall of Moultrie Creek from State Road 16 to tidewater is on the order of one foot per thousand feet, or a slope of slightly less than 0.1 percent. This slope represents a relative balance between slope stability of the area's sandy soils and stormwater runoff from the plateau in recent geological times.

Heavy rainfalls and subsequent runoff from the 30 to 40 foot high plateau gradually cut deep stream channels in the fine ocean deposited sand mantle materials. Continual cutting or erosion of the sides of the steep stream channels typical of Moultrie Creek and its tributaries can be expected to occur within the watershed following heavy rainfalls. As development occurs and unless stormwater is retained or stored on lands improved for development, accelerated eroded materials and contaminants from developed lands will be discharged into the Matanzas River in increasing quantities over time.

On the plateau of the watershed, numerous large and small shallow depressional areas currently maintain wetland vegetation. Many of these depressions are isolated or have no natural drainage channel to established stream courses. Normal rainfalls are retained within these depressions, with some of the rainfall infiltrating and percolating water to the ground water table. Very heavy rainfalls often fill depressions and allow sheet water flow to move across normally drier areas to other depressions or to stream courses.

4

SOILS AND WATER TABLE CONDITIONS

SOILS

General

The term, Soil is typically applied to the weathered surface layer of sediment materials. The science of soils has been highly developed by the U.S. Soil Conservation Service (SCS) in support of the nation's agricultural needs. The materials used in this investigation are heavily dependent upon information provided by the Soil Conservation Service through the Soil Survey of St. Johns County, Florida. The Soil Conservation Service classified the soils in the study area according to a variety of characteristics such as soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that would identify the soils. This information is highly valuable for general identification of areas with unique surface sediment characteristics. The information is suitable for preliminary engineering determination of potential problems to expect within given areas, and the soil survey information has been used for this purpose in this study.

Soil survey information does not replace the need for site specific field and laboratory analyses required to insure that load bearing and other construction design parameters are adequate for an engineered project.

Engineering Factors

The soils underlying the Moultrie Creek watershed are essentially comprised of silica sands deposited as marine sediments. All upland soils in the study area, not subject to prolonged flooding, are classified as fine sands with more than 50 percent of the material passing a #40 sieve and less than 50 percent passing a #200 sieve. Typically, at least 75 percent of the materials pass the #40 sieve and less than 20 percent pass the #200 sieve. Being primarily silica sands, the surface materials generally are not subject to liquid limits and are not plastic. The very fine silts and clay components and organic matter are typically low within those soils not subject to periodic and prolonged flooding. Correspondingly, soils with low clay and organic matter content in the study area tend to be highly permeable and typically have low available water and low water holding capacities.

Soils with low available water also are less affected by capillary rise of water in soils. Capillary rise results from the direct suction of the atmosphere due to differences in pressure between the air and the soil water. Capillary rise is more pronounced in soils with higher contents of clays, silts, and organic materials. A capillary rise of as much as 18 inches can be expected to occur in clay and clay loam soils.

In the fine sands typical of the Moultrie Creek watershed, a capillary rise of less than six inches would be expected. This phenomenon is an important consideration in roadway design. Roadway load bearing capability decreases when the subgrade supporting the road surface becomes saturated. The result is the familiar cracking of pavements into an alligator hide look. When the surface pavements protecting the load- bearing subgrade becomes broken through cracking processes, the roadway quickly deteriorates.

The alligator cracking roadway deterioration process can be alleviated by insuring that the bottom of the road subgrade is built above local high water table conditions. The road subgrade bottom should be further elevated in fine sandy soils another 6 or more inches to reduce the soil saturating effect of capillary rise of water above the height of the annual high local water table.

Roadway construction and repair is a major tax dollar expenditure of the St. Johns County government. Review of water table conditions, subsoils, subgrade materials, roadway construction procedures, and local area drainage are essential before the County agrees to accept a privately constructed roadway system.

The following information provides general guidance on the natural soils and normal water table conditions found within the Moultrie Creek watershed. This information also provides useful guidance for determining the stormwater management needs within the watershed.

Soil Porosity and Water Storage Capabilities

The ratio of openings or voids between soil particles and the total volume of the soil matrix is referred to as soil porosity. Porosity is normally presented as a ratio or percentage of void area per total area of the soil matrix. For sandy soils, total porosity is normally considered as 25 percent of the total soil matrix. Within this 25 percent of the soil matrix, part of the void space is occupied by air. The trapped air reduces the potential for water storage in the surface soil materials. Part of the void area is also occupied by capillary water that is specifically retained or bound to the soil particles.

In sandy soils, specific retention losses may be estimated at about 15 percent of the total porosity. For saturated soils, a generalized estimate of the specific yield of a sandy soil matrix, or the part of water stored in a soil that will drain under the influence of gravity, may be estimated at 22 percent of the unit area volume. This percentage also provides an approximate estimate of the accessible water in saturated fine sands. (Center for Environmental Research 1985, Frevert 1955, Resource Control Department, SFWMD 1983).

The U. S. Soil Conservation Service provided the following estimates of soil water storage capability for the normal sandy soils found within the South Florida Water Management District. Until different information is established for St. Johns County, these values provide preliminary guidance for estimating potential water infiltration volumes into local fine sand soil matrix areas.

Depth to Water Table	Cumulative Water Storage
1'	0.6"
2'	2.5"
3'	6.6"
4'	10.9"

The above values are applicable to soils in their natural state. The cumulative water storage capabilities of sandy soils that have been compacted intentionally or through usage, typically those associated with urban activities, should be reduced by 25 percent. This reduction factor would be applied to any proposed use of an open area. Consideration of the use of soils occurring under impervious areas, when calculating an area's water storage potential, requires still further adjusted estimates. Water can be introduced beneath impervious areas at reduced percent-ages, as compared with a natural land area, but only when sufficient air bleed mechanisms are installed to prevent trapped air from further reducing the soil water storage potential.

Soil Permeability

Soil permeability is the quality of a soil that allows it to transmit water or air. Permeability refers to the rate at which water moves through the soil. The term should not be confused with the perviousness or water storage capabilities of soil which determines the amount of water that can be withdrawn from, or stored within, a soil matrix. The permeability of soils is referred to as the percolation rate when applied to septic tank drain field requirements. Permeability is measured by engineers and soil scientists in terms of the number of inches per hour water will seep or flow (usually downward by gravity) through a cross section of soil.

Soil survey data indicate that the surface layers of the fine sands within the Moultrie Creek watershed would be classified as having rapid permeabilities (5.00 to 10.00 inches per hour). The excessively drained soils typical of upland sand dunes have very rapid permeability rates (over ten inches per hour). At varying depths below the surface materials, soil permeability data show zones with moderately slow permeability rates (0.20 to 0.80 inches per hour) in many of the area's soils.

The upper one or two feet of most soils in the Moultrie Creek watershed have rapid permeability ratings. At varying lower depths, permeability becomes moderately slow. The lower permeability rates may result from confining layers or saturated soil conditions. In many localities of the Moultrie Creek watershed, the surface soils are fully capable of accepting more than the first one inch of every rainfall within relatively short periods of time.

The surface soils with zones of lower permeability typically are associated with depressions, floodplains, and flatwoods, all areas with naturally high water tables. Zones of lower soil permeability within these areas often are associated with the top of local water tables. As water percolates downward, it carries organic and inorganic sediment fines largely developed from decomposed and reduced plant materials. Downward percolation of these materials is stopped by the density of water near the top of the water table. Continued percolation carrying sediment fines to the vicinity of the water table gradually clog the pore spaces between the silica sand materials, reducing permeability. A wide variety of biological actions and chemical reactions occur to produce these zones of lower permeability, but the available information can be used to generally determine the normal depth to water table in localities within the watershed.

Once zones of reduced permeability are developed within sandy soils by the above process, increased soil permeability in the affected zones can only be increased by permanently reducing water table levels in these areas and by fracturing or otherwise disturbing the confining zones to re-establish permeability. Both of these practices have been widely used in Florida to improve lands for agricultural and urban development purposes.

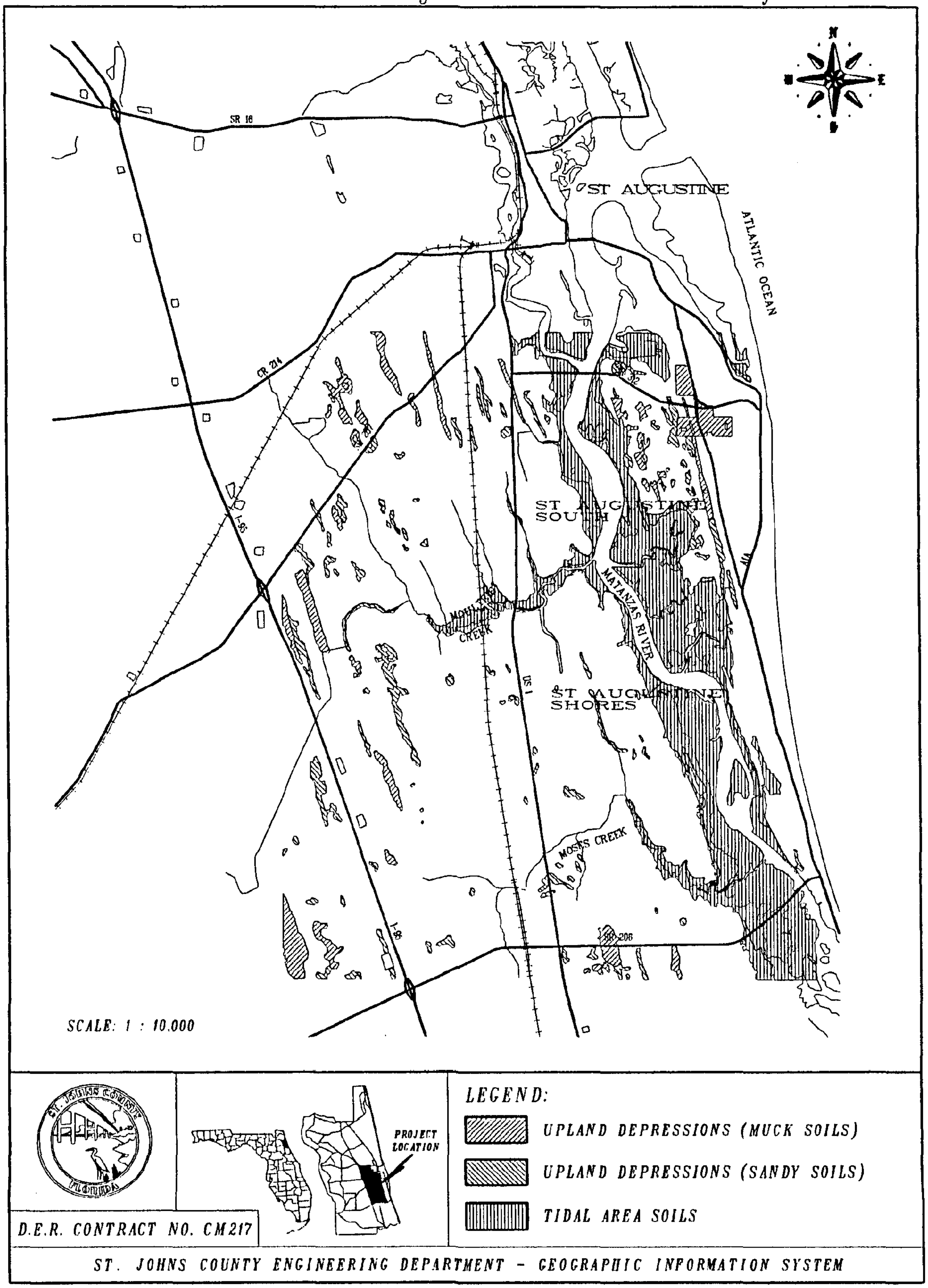
Watershed Soils Distribution

Within the numerous shallow depressional areas occurring throughout the watershed plateau, decomposition of detrital materials and the transport of these materials with runoff from locally higher areas to the depressions has resulted in localized and often isolated accumulations of silts, clays, and organic materials. Those depressional areas with significant clay and organic materials accumulations typically have high water table conditions with ground water emerging and flooding the depressional areas for extended periods. Those watershed localities identified in the soil survey as having water tables rising above, or flooding, land surfaces part of each year are generally displayed on **Figure 4-1. Localities With Water Tables Rising Above Land Level Part of Each Year.**

The areas identified in Figure 4–1 include some of the same areas described later in this study as significant natural resource areas. The areas displayed on Figure 4–1 include as a grouping the following soils series found in St. Johns County: (A) freshwater depressional areas with muck soils including the following soil series: Samsula muck (26), Hontoon muck (35), Tomoka muck (41), Bluff sandy clay loam, frequently flooded (42), and Bakersfield muck (69); and, (B) freshwater depressional areas with mineral (silica sand) soils including: Myakka fine sand, depressional (4), St. Johns fine sand, depressional (5), and Riviera fine sand, depressional (61). Some of these soils series are not found in the Moultrie Creek watershed but are important on a County-wide basis.

Soils subject to extended periods of flooding annually can be identified by accumulations of dark colored organic matter as peat or muck, a predominance of mottling with dark brown and grey colors staining the normally light colored

Figure 4-1. Localities With Water Tables Rising Above Land Level Part of Each Year



natural sands, or the characteristic dark grey color of iron accumulating under anaerobic conditions characteristic of saturated or flooded soils. Red stained soils are characteristic of iron accumulations after oxidation of the iron has taken place. The generalized soil characteristics of soils subject to periodic flooding also can be used to identify soils that serve as shallow drainageways connecting larger depressions to more clearly defined stream channels.

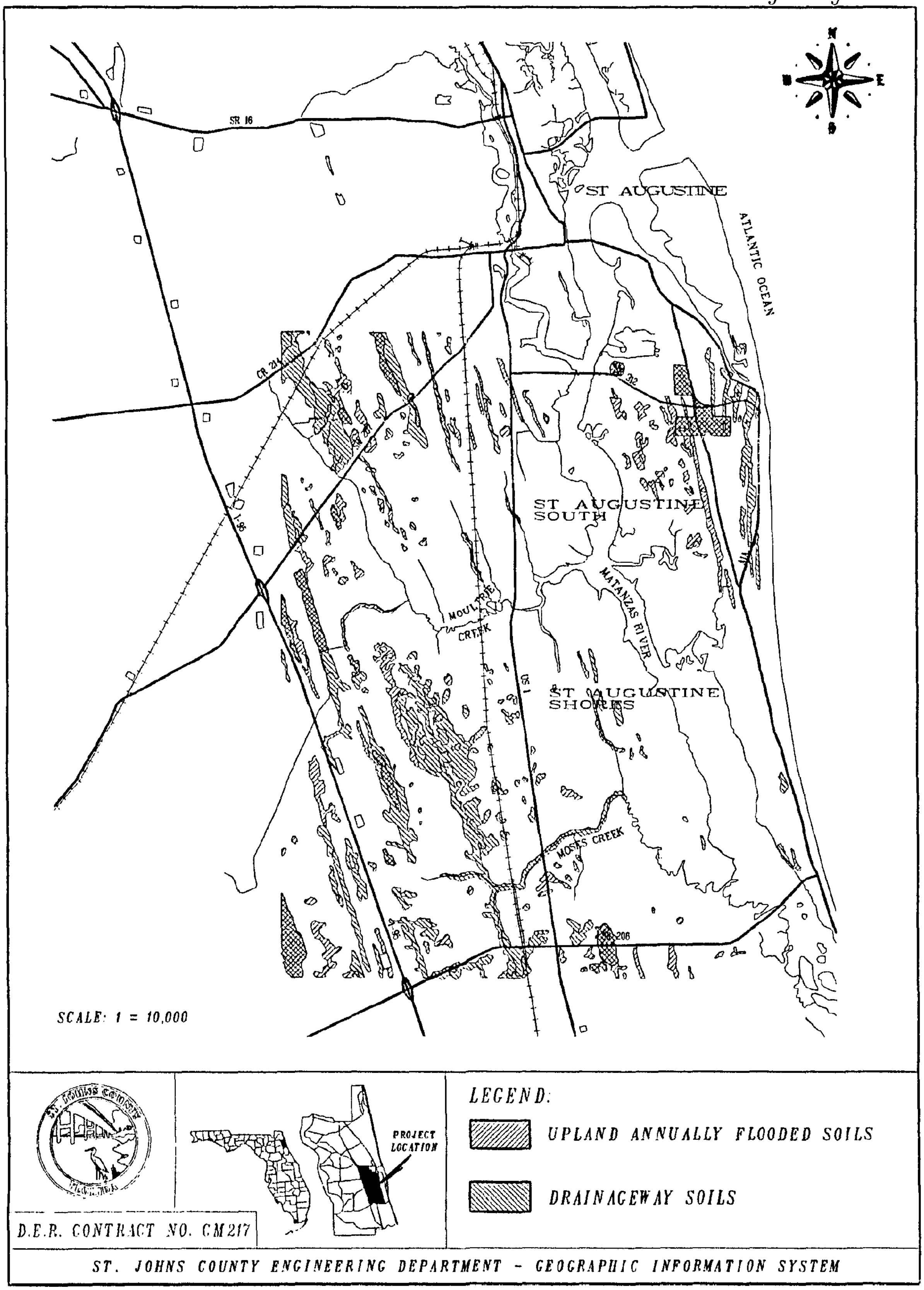
Also included in Figure 4-1 are tidal area soils. These soils are flooded periodically due to tide conditions. Tidal area soils and immediately adjacent areas are subject to occassional storm tides reaching elevations of 8 and 9 feet above mean sea level in Moultrie Creek. Soils found in tidal areas are: Pellicer silty clay loam, frequently flooded (24), Moultrie fine sand, frequently flooded (49), Durbin muck, frequently flooded (52), and Tisonia mucky peat, frequently flooded (67).

The Moultrie Creek watershed has a poorly defined natural drainage system. Figure 4–1, above, displayed those fresh water areas normally flooded for parts of each year. Many of the soil series that identify shallow drainageways carry surface water as runoff only following rare, very heavy rainfalls. In character with poorly drained flatwoods soils, the shallow drainageway soils tend to become fully saturated during part of each year as a result of high water table conditions. Some of these soils are also found on the floodplains of established streams.

Figure 4-2. Annually Flooded Soils and Drainageway Soils, displays the relationship of annually flooded soils with natural drainageway soils. The soils displayed in Figure 4–1 appear in Figure 4–2 grouped as upland annually flooded soils. Also displayed in Figure 4–2 as a second group are the soil series classified as shallow drainageway soils in St. Johns County including: Floridana fine sand, frequently flooded (18), Pompano fine sand (19), Manatee fine sandy loam, frequently flooded (22), Parkwood fine sandy loam, frequently flooded (25), Wesconnett fine sand, frequently flooded (30), Riviera fine sand, frequently flooded (36),Tomoka muck (41), Bluff sandy clay loam, frequently flooded (42) (a muck soil of drainageways and floodplains), Holopaw fine sand, frequently flooded (47), Winder fine sand, frequently flooded (48), and, Terra Ceia muck, frequently flooded (66) (a deep muck found on the floodplains of rivers and streams). Some of these soil series are not found in the Moultrie Creek watershed but are important on a County-wide basis.

Figure 4–2 provides a generalized display of the natural surface water storage and drainageway system in the Moultrie

Figure 4-2. Annually Flooded Soils and Drainageway Soils



Creek watershed. Adjacent to this system are poorly drained drainageway fringe and flatwoods soils. **Figure 4-3. Floodprone/Drainageway Soils and Naturally Saturated Soils,** displays the relationship of the natural surface water storage and drainageway system with the drainageway fringe and flatwoods soils. These soils typically become saturated during a part of each year or have water table waters rising to, or within one foot below, the land surface. Naturally saturated soils identified in the soil survey include: Myakka fine sand (3), Immokalee fine sand (7), Pomona fine sand (9), Smyrna fine sand (11), Ona fine sand (12), St. Johns fine sand (13), Floridana fine sand, frequently flooded (18), Pompano fine sand (19), Wabasso fine sand (21), Manatee fine sandy loam, frequently flooded (22), Parkwood fine sandy loam, frequently flooded (25), Wesconnett fine sand, frequently flooded (30), Tocoi fine sand (34), Riviera fine sand, frequently flooded (36),Pottsburg fine sand (40), Bluff sandy clay loam, frequently flooded (42), Holopaw fine sand (46), Holopaw fine sand, frequently flooded (47), Winder fine sand, frequently flooded (48), Immokalee-Urban land complex (53), Eau Gallie fine sand (58), Floridana fine sand (62), Placid fine sand (63), Ellzey fine sand (64), Riviera fine sand (65), Terra Ceia muck, frequently flooded (66), and Winder fine sand (68).

Any developed use (including roadways, buildings and other facilities or structures) on the drainageway fringe and flatwoods soils will require control of, or consideration for, the annual rise of the water table. Any effort to drain these lands should be undertaken with a full understanding of the long range impact of total area development drainage upon local ground water table conditions, the potential decline of surficial aquifer water supplies, and the resulting potential of increased salt water intrusion from the Floridan aquifer and sea water into the surficial aquifer.

Under significant rainfall events, flatwoods areas also are affected by extensive, shallow flooding. Historical development practices have simply resorted to ditching and draining. Some draining combined with adequate detention/retention storage systems, controlled drainage systems, and a variety of development control measures can provide for development in flatwoods areas of the Moultrie Creek watershed and still protect the area's ground water resources and significant natural areas.

Based upon soil survey information, significant parts of the Moultrie Creek watershed are free of potential flooding or can be developed with minimum negative impact upon ground water table conditions. **Figure 4-4. Well To Excessively Drained Soils** displays those soil series within the watershed with well to excessively drained soils and local water table con-

Figure 4-3. Annually Flooded/Drainageway Soils And Naturally Saturated Soils

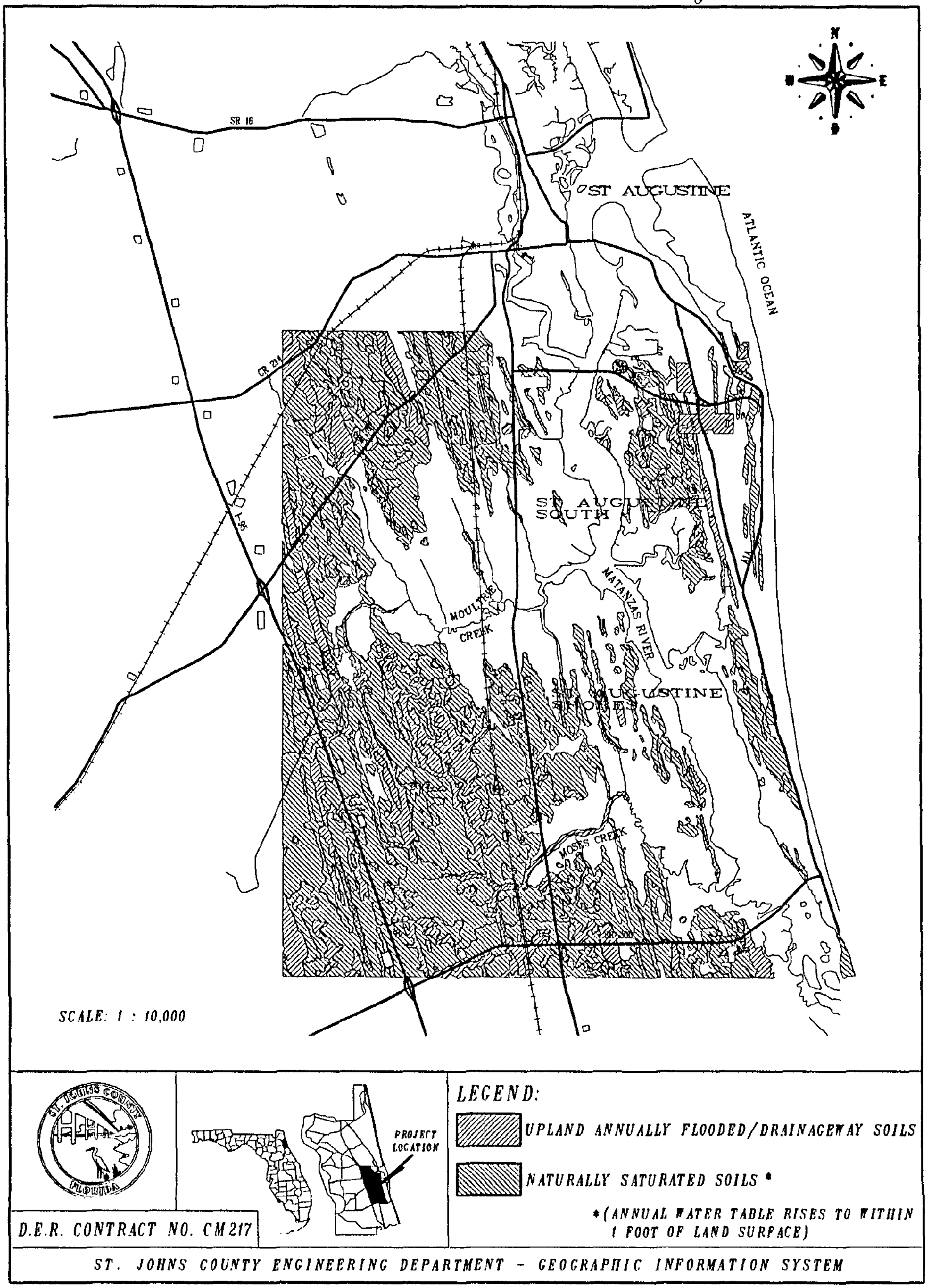
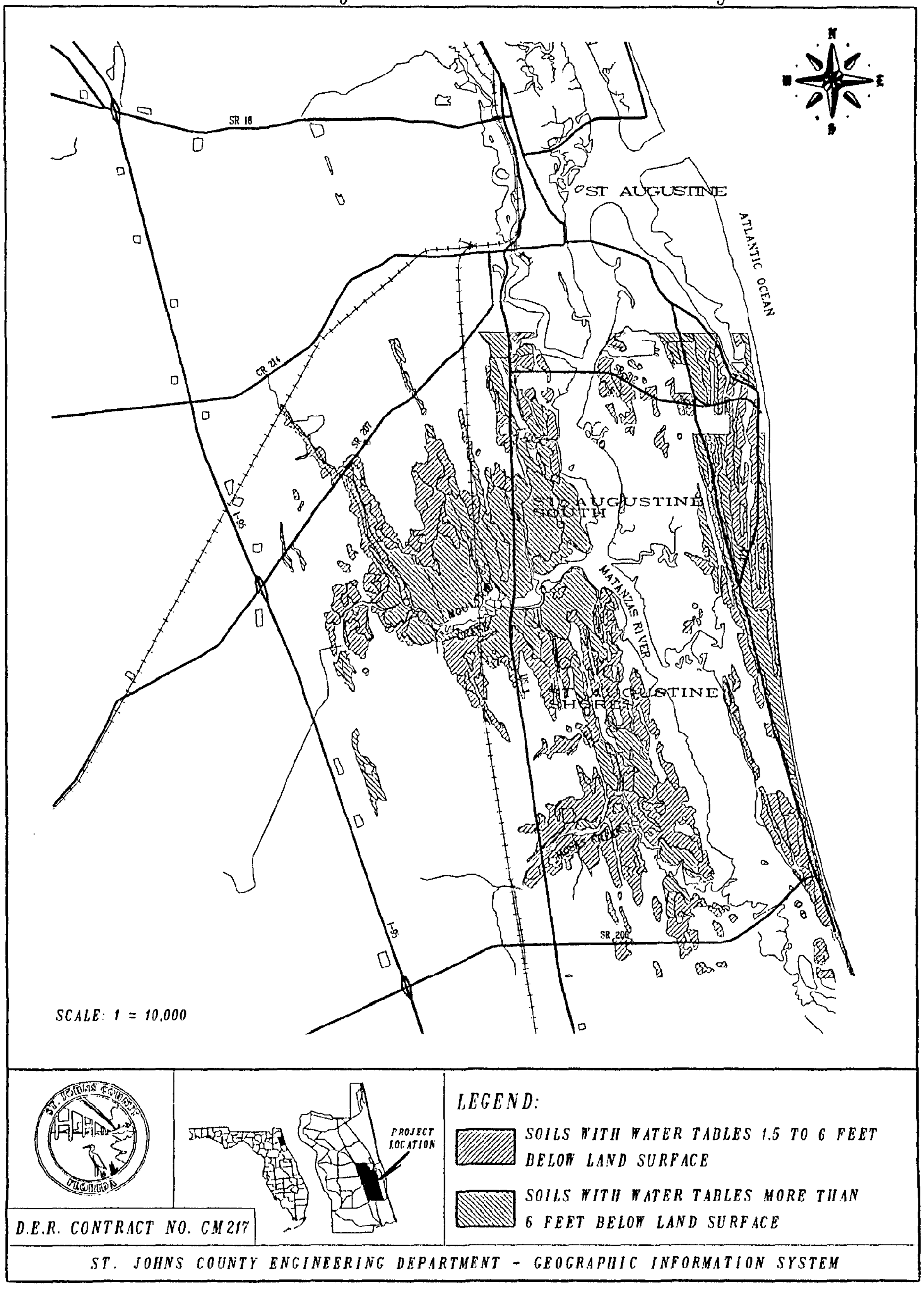


Figure 4-4. Well To Excessively Drained Soils



ditions where ground water does not reach the land surface. The group of soils identified as having ground water tables more than six feet below ground surface include: Astatula fine sand, 0 to 8 percent slopes (2), Paola fine sand, 0 to 8 percent slopes (23), Fripp-Satellite complex (31), Palm Beach sand, 0 to 5 percent slopes (32), and, Astatula Urban land complex (54). These soils occur along the plateau edge and the tidal portions of Moultrie Creek and the Matanzas River. The plateau in this locality is 20 or more feet above sea level. The water table is well below ground level because the ground water is flowing by gravity to sea level and emerges as seepage where the land merges with the tidal flats.

Further inland along Moultrie Creek and upstream of tidal influence, the incised stream course occurs at elevations ranging from sea level at tidewater to less than 15 feet at State Road 207. The average plateau land surface throughout this area is at an elevation of nearly 30 feet. The gravity flow of ground water in this part of the watershed would be towards the lower land elevation of the stream bed with a resultant effect of a significantly lowered ground water table in areas adjacent to the stream course.

Inland and upstream along Moultrie Creek from the localities with water tables at least six feet below the land surface are soils with intermediate depth water tables. Figure 4-4 displays as a second group the soils with water tables at least 1.5 feet below land surface. In St. Johns County, these soils include: Adamsville fine sand (1), Tavares fine sand, 0 to 5 percent slopes (6), Zolofo fine sand (8), Cassia fine sand (14), Pomello fine sand, 0 to 5 percent slopes (15), Orsino fine sand, 0 to 5 percent slopes (16), St. Augustine fine sand (27), Satellite fine sand (29), Jonathan fine sand (33), Sparr fine sand, 0 to 5 percent slopes (44), St. Augustine fine sand, clayey substratum (45), Narcoossee fine sand, shelly substratum (50), St. Augustine-Urban land complex (51), and Adamsville Variant fine sand (57). Some of these soils may not occur within the Moultrie Creek watershed, but are important for County-wide application.

The soils having intermediate height water tables occur between the more poorly drained flatwoods soils and the excessively drained soils. The water table heights probably are controlled by the natural slope of the water table as the ground water flows by gravity from the highly saturated interior soils of the plateau towards lower land surface elevations along Moultrie Creek and finally to tidewater and sea level.

RAINFALL CONTRIBUTIONS TO GROUND WATER

Infiltration and Percolation

As rainfall occurs, part of the rainwater infiltrates or seeps into the soil. Once in the soil, it moves by gravity or percolates downward to the water table. The rate at which the water is able to move through the soil matrix is referred to as the soil permeability. The terms soil permeability and soil hydraulic conductivity are essentially the same.

The rate at which rainfall infiltrates into the soil varies with soil structure, soil compactness, and the degree of wetness of the surface soil particles. Water can move more rapidly into course sands than into fine sands because of the larger void areas between the particles in the course sands. Water infiltrates very slowly into soils high in very fine silt and clay particles. Recently disturbed or broken soil surfaces permit more rapid water infiltration than well compacted or undisturbed soils. When soil surfaces are completely dry, water tends to bead on the soil particles until the weak electromagnetic bond between the soil and air molecules is broken. The time required for this process to take place varies with different types of soils, temperature conditions, and with the degree of dryness of the soil.

Percolation within the soil matrix is also dependent upon soil wetness. Water moves more rapidly through wet soils. If soil is allowed to dry out to significant depths, percolation will be slowed until the soil matrix becomes thoroughly wet.

Urban area soils tend to be compacted, and when overdrained, the soil surface and upper several inches of soil can become extremely dry, with temporarily reduced permeability. In Florida's sandy soils, a vegetation cover retards the soil drying process by shading the soil surface and by lifting water from lower elevations through the plants' root system. The vegetation mat of detrital material and the decomposed organic matter in the upper soil horizon provide the means for sandy soils to hold water. The water, in turn, slows down the oxidation rate of the organic fraction of the surface soil matrix.

Unshaded sands can become dry to depths of six or more inches during the spring and summer months within a week or so following a rainfall. When these conditions are allowed to occur, rainfall that does not pond for a sufficient time for the infiltration process to occur must runoff. Under these conditions, the typically short-duration, relatively intense, annually occurring summer showers contribution to ground water recharge requirements can become very limited.

Water Table Conditions

General Concepts

Water that percolates downward continues to move to a point where gravity forces and forces associated with capillary water movement, or suction forces, become balanced. If enough water enters the soil, it eventually percolates to the water table, the natural level within the soil mantle or matrix below which all voids between soil particles contain water. In most parts of St. Johns County, the water table is also the effective top of the surficial aquifer.

The water table beneath the Moultrie Creek watershed is not a flat surface. Under every knoll or ridge, the water table is higher than under swales or depressions. Rainfall on knolls and ridges percolates to the soil matrix saturation zone directly beneath the knoll or ridge land surface. These localities, being at higher elevations, are the primary ground water recharge areas within the County. From the saturated soil zones under knolls and ridges, the ground water moves by gravity along a hydraulic gradient to the saturated soil zones of land surfaces with lower land elevations. The lower land surfaces may be natural swales, or larger depressions.

When depressions have standing water, the elevations of that standing water generally reflect the height of the local water table. The wet edges of the depressions identify the seepage points from which ground water is slowly moving downward along a hydraulic gradient from beneath adjacent knolls and ridges and is emerging as surface water in the depression.

The movement of ground water and seepage is generally imperceptible, except during periods immediately following heavy rainfalls on the adjacent uplands. Whenever wet perimeters or seepage zones are observable along edges of depressions, the water table under adjacent uplands is higher than the observed seepage zone.

The hydraulic gradient or slope created by the water under upland areas flowing to depressions is steepest immediately following periods of high infiltration rainfalls. Gradually, the mounded ground water decreases in height as it is lost to seepage and other factors. As the height of the water becomes reduced and the slope to the seepage point is lowered, the movement or flow of the ground water also diminishes.

As a result of the above process, the ground water table is in a continual state of fluctuation. Every major rainfall allows some water to infiltrate. Repeated moderate rainfalls of intensities low enough to allow infiltration to take place can provide significant recharge to the water table. Because soils accept water slowly, intense rainfalls result in high runoff from the land and the water is largely lost relative to ground water recharge needs.

At the opposite extreme, prolonged drought periods typically result in a progressive decline in the height of the water table. Based upon St. Johns County Soil Survey information, natural water table fluctuations on the order of three or more feet are normal each year beneath flatwoods soils. The ground water is always moving along some hydraulic gradient to points of lower land elevation.

Moultrie Creek Effects

The stream bed of Moultrie Creek is the most significant low land surface point within the interior part of the basin. Unless repeated recharge occurs at land elevations adjacent to and extending from Moultrie Creek, prolonged drought conditions can result in significantly lowered ground water tables extending outward on either side of the incised portions of the Moultrie Creek stream course. The lowered ground water table and excessively drained soil conditions in the watershed noted in the Soil Survey are directly related to the affected soils' close proximity to the lowest land elevations along Moultrie Creek and the Matanzas River.

Uncontrolled drainage directed to Moultrie Creek removes stormwater before it can infiltrate and provide recharge to the ground water. Because this water has been diverted, the source of water that permits extended base flow in Moultrie Creek is being eliminated. As this base flow and the general ground water table is allowed to decline in the vicinity of Moultrie Creek, salt water can be expected to move slowly into those areas previously supplied by the gradual movement of ground water from areas of higher elevation.

During normal seasonal low elevation periods of the water table, surface water in the fresh water natural resource areas (depressions and natural drainageways) become lowered or disappear. As long as the bottom materials of these areas remain moist, the natural regeneration of vegetation in these areas can continue. If, however, extended drought conditions occur, new growth and young plants with shallow roots can be lost. An uncontrolled drainage program that permanently lowers the water table beneath these areas will also prevent any regeneration of new growth. The natural area will then begin a transitional process where vegetation that can sustain itself with less water will begin to replace the original species.

Perched Water Tables

The extent of perched water table conditions within the watershed is unknown. A perched water table usually occurs in a depressional area where local conditions prevent downward percolation of ground water to the area-wide water table. When the general area water table permanently falls below the bottom elevation of a depressional area and wet soils in the depression persist, the condition is representative of a perched, and highly localized, water table. These areas typically reflect former natural water table conditions.

Upland depressional areas tend to accumulate detrital materials and sediment fines that are transported with runoff from adjacent lands of higher elevations. Chemical and bacterial action within the depressional environments act to convert organic materials into fine organic and inorganic compounds and combine the compounds into stable, often denser materials.

As a result of the above processes, dense and relatively impervious clays tend to underlay depressions with continually saturated soils. Where this phenomenon occurs, a periodic water table decline below the bottom of the depression may have a delayed impact on the vegetation growth cycle in the depression. To the degree that thick water holding materials can be maintained in such depressions, existing vegetation characteristics can be maintained for long periods of time. Maintenance or restoration of perched water table areas requires the application of sufficient water to reestablish near natural hydroperiod conditions.

Water Table Management

Initial Considerations

For development purposes, the height of the water table in local areas must be known, and the height to which the water table is to be maintained must be determined. The Soil Survey information provides general information on the natural height of water table conditions for specific series of soils. Correlation of this information with one foot contour information will provide guidance for determining natural water table heights and seasonal variations of these heights. Once governmental policy determines the area features and ground water conditions essential for residents' health and welfare, engineering analysis can establish the criteria and methods for accomplishing the policy decisions.

Development Alternatives

Unless specifically designed for high water table conditions, all load bearing foundations of structures and subbases of roadways must remain above normal water table heights to retain structural integrity. As noted previously, normal capillary rise of water in sands with some fines will normally be less than six inches. Therefore, as a minimum engineering requirement, the bases of roadways and foundations should be at least six inches above expected annual heights of local water tables. Under those conditions where road bases are close to the annual high water table, road base and foundation designs would have to accommodate the reduced load bearing capabilities of periodically saturated soil conditions.

Four courses of action are open for development on high water table soils. Traditional practices consist of permanent lowering the water table by positive and uncontrolled drainage. This practice results in the total drying of surface soils during seasonal and extended drought periods.

The second course of action consists of the recontouring and raising of the land beneath all load bearing facilities. The bases of both roadways and structure foundations can be raised. In both cases, the practice of constructing roads and structure foundations on compacted non-plastic fill materials is now common in Florida. Monolithic home slabs constructed on three and four feet of compacted fill have become routine construction practice in some Florida communities. Raising roads above 100-year flood elevations ensures user safety during flooding emergencies and provides for emergency vehicle access to and from flood prone areas.

A third option consists of the specific design of road bases and foundations for high water table conditions. Under heavy loads, saturated fine sands can move very rapidly from a nonplastic material to a liquid state with greatly reduced load bearing capability. Hydrated lime mixtures with added fines have been successfully used to stabilize saturated fine sand soils in Florida. Soil cement mixtures are also usable when the water content of the soil can be carefully controlled during the curing process. As with hydrated lime stabilization, soil cement requires the addition of some fines to achieve sufficient load bearing strength. Spread footings of soil cement or hydrated lime also can be used as bases for structure foundations in wet areas.

A fourth option consists of mixtures of the first three approaches. In upper flatwood soils areas, some lowering of the ground water table may be possible without significantly impacting overall water table conditions. In lower flatwoods and drainageway soils areas, however, positive drainage could be expected to negatively impact the water table, and compacted fill practices would be necessary. For example, the placement of two feet of compacted fill to raise roadways and two feet of compacted fill for house pads (an elevated base upon which concrete house slabs are placed) would eliminate most property flooding potentials, provide for safe road access to properties, and provide for temporary water storage in remaining open areas during the infrequent heavy rainfalls characteristic to Florida. Where development is essential and fill practices cannot provide satisfactory results, design practices for high water table conditions may become necessary.

Public and Private Property Owner Concerns

Because of generally lower initial costs, positive and uncontrolled drainage to permanently lower water tables is a preferred action by developers, while designing for building and roadway structural integrity, safe use of roadways and access to properties during infrequently heavy rainfalls, and storage of stormwater in areas of high water table or saturated soil conditions have higher associated development costs. The County's concern is the integrity of the construction practices for the long–term health and welfare of citizens. It remains for private entrepreneurs to determine whether the costs of proposed developments achieve required short term profitability. The County is also concerned about the costs of infrastructural repair and maintenance. For example, a roadway constructed as a private venture can only be accepted as a public facility when the County can be assured that sound engineering practices are followed by the constructor of that road.

Management Criteria

The natural annual fluctuation of localized area water table heights provides the best general guidance available for establishing criteria for the design of stormwater management systems in high water table areas. The annual low elevation of the water table in high water table localities reflects the maximum safe depths for constructing drainageways and channels. The annual high elevation of the water table in high water table localities reflects the lowest elevation at which water storage containment facilities can be assured of functioning at complete capacity throughout the year. Design of stormwater management facilities to these criteria will assure the maximum possible protection to the surficial aquifer and significant natural resource areas.

Simplifying the above and providing for a standardized procedure for the entire County is necessary. Any parcel proposed for development in the County should have the maximum and minimum land elevation of that parcel and immediately adjacent parcels established. The points of maximum and minimum should be identified and clearly marked on the development drainage plan. Large parcels and parcels with significant land contour changes would need determinations by segments with common characteristics. Using this information, the localities on the parcel representing the mean land elevation should be presented. This process will establish the natural sheet flow, infiltration, water table, and ground water hydraulic gradient tendencies of a parcel.

The annual high water table will be assumed to extend to within one foot of the land surface at the parcel's mean land elevation unless Soil Survey data or documentation by a registered engineer are provided to establish a different natural annual high water table elevation for critical segments of parcels. An approved annual high water table condition for the parcel or delineated segments will be used as the base elevation for the design of stormwater containment facilities.

5

STORMWATER STORAGE

WATER CONTAINMENT

General Considerations

Depressional areas represent natural rain water storage locations within a watershed. As these areas become filled, the water begins to move via a drainageway to some nearby depression or to a stream course. A primary focus of drainage engineering is the estimation of the amount of water likely to runoff from a watershed under some given rainfall condition and the design of some water control works to safely move the runoff from one place to another.

Stormwater management oriented towards the most useful retention of water for ground water recharge and significant natural area protection has a different engineering focus. These purposes require the design of storage facilities to retain runoff from normal rainfalls expected on an annual basis. Once this requirement is met, the overflow water from the infrequent and heavier rainfalls must be detained and safely removed at controlled rates to avoid significant erosion and sedimentation damages to receiving water areas.

In hydrological analyses of potential runoff from a watershed, estimates are made of the amount of rainfall received by a watershed that is retained or lost before runoff begins. This initial retained or lost amount is referred to as the initial abstraction, a best initial estimate of water losses due to water storage and other factors to be subtracted from the calculated runoff. For normal or non-compacted soils, the U. S. Soil Conservation uses an estimate of 0.2 inches as an initial abstraction estimate. The drainage engineer's efforts then focus upon the additional rainfall amount that produces runoff water and how to design water control structures to accommodate such flows.

Part of the water lost to runoff through storage on the land infiltrates into the soil matrix and is gained by the ground water storage system. Revisions in drainage system design criteria are required to give greater emphasis to the retention of normal annual rainfalls while still providing for removal of unusual or infrequent rainfall events. Engineering analysis to determine the greatest beneficial uses of stormwater prior to runoff has now become the area of concern in the design of stormwater management systems.

Stormwater Containment Purposes

Detention/retention storage or containment for ground water supply recharge through infiltration must be emphasized in the vicinity of the land surface areas beneath which surficial aquifer water is withdrawn. As water is withdrawn from the surficial aquifer at depths of 90 or 100 feet below land surface, water moves slowly towards the well head from all directions. The pumpage effects cause a lower water pressure to develop at the well head. As more water is withdrawn, a decreased pressure zone forms from the well head as the apex, the area of decreased pressure, extends outward and upward towards the land surface with an expanding circumference creating the general form of a cone. This is called the cone of depression for that well, and ground water moves from all points with greater amounts of water at higher pressures towards the apex of the cone. As the cone of depression extends to the land surface, the water table within that cone of depression declines, and the overlying surface soils begin to dry out.

The size of the cone of depression depends upon the well size and withdrawal rates. Major agricultural and municipal system wells may be expected to measurably influence water tables in sandy soils for distances of 1,000 or more feet from the well. Without adequate recharge, the water table declines can become progressively extended over larger areas. Increasing storage of stormwater and the diversion of stormwater towards cones of depressions are essential if the locally severe water table declines in the vicinities of large well fields are to be avoided.

Protection of significant natural areas in uplands can be accomplished through control of water table conditions. Maintenance of high water tables requires retention and detention storage and control of runoff. Increased use of stormwater storage facilities designed to retain most of the expected annual rainfall can provide long-term protection of natural water table conditions. Continuation of positive drainage programs in the interior flatwood soil areas of the Moultrie Creek watershed will result in the gradual drying of nearby depressional areas.

In areas with excessively drained soils and where septic tanks are used, detention/retention storage and subsequent infiltration can be expected to augment the diffusion of septic tank effluents that can percolate towards the water table. Most of these areas occur along the tidal portions of Moultrie Creek and the Matanzas River. Numerous individuals within these areas also use private wells, some which may serve as sources of potable water. Two ground water problems are apparent in this part of the watershed. As development increases and more people utilize individual wells, water withdrawals can be expected to exceed natural recharge capabilities in local areas. As this occurs, as it has in communities all around coastal Florida, saline ocean water will move into the composite cones of depression formed by the close groupings of the withdrawal wells.

The second problem is public health related. Water wells in the surficial aquifer are typically drilled to depths of less than 100 feet. As the cone of depression formed by a single well or a close grouping of wells approaches the land surface, septic tank effluents will be drawn downward. Septic tank drain fields function by distributing effluents into the upper 18 inches of the soil matrix where aerobic bacteria can render pathogens harmless. The process requires that the effluents remain in the upper soil zones for some extended period of time for the soil bacteria to render them harmless.

Numerous studies have been conducted around the country illustrating that some pathogens can remain viable for many days and weeks under anaerobic conditions characteristic of saturated soil matrix materials in the surficial aquifer. Excessive water withdrawals can lead to the introduction of these pathogenic materials into the well water withdrawn from the aquifer.

Finally, numerous studies nationwide have determined that stormwater detention/retention facilities can help reduce pollutant loads characteristically found in urban runoff. The Florida Department of Environmental Regulation has established a state policy for the retention of the first one half inch of runoff from storms.

Stormwater Containment Criteria

In an effort to reduce the water pollution impacts of stormwater runoff upon lower property owners, public stormwater conveyance facilities, and as a water pollution reduction measure, St. Johns County has adopted the following stormwater containment measures. Any parcel proposed for commercial or industrial use and any parcel proposed for use as a residential subdivision is required to provide retention facilities for stormwater. A single containment facility or the composite capacity of several facilities will be sized to accept a volume of water equivalent to the greater volume of either one half inch of runoff water distributed across the entire parcel or one inch of runoff water distributed across the total impervious area within the parcel.

Under primarily rural development conditions, the above containment measures would provide some protection for water elevations in the surficial aquifer where extensive positive surface water drainage had not been practiced. Under the population increases occurring within the County and projected populations in the immediate future, the above criteria can be expected to result in a continued decline in water tables and long term water supply potentials of the surficial aquifer.

As an immediate measure, retention facilities designed to store the first one inch of every rainfall from the drainage area of that facility would more adequately serve water pollution control, water supply recharge, and significant natural resource area requirements. On larger land parcels, a number of small retention facilities would provide a distributed and more effective system for ground water recharge than a single large retention facility. The potential benefits of storing the first one inch of rainfall appear in Table 2-2.

Storing the first one inch of every rainfall on developed properties should be considered as an interim and minimum water resource protection measure. The preliminary information presented in this report suggests that more stringent measures actually may be necessary to assure the long-term viability of the County's water resources. More detailed studies of the County's total water resource needs will be needed to make that determination.

Preliminary Design Concepts

In recent years, stormwater detention and retention facilities have been incorporated into the stormwater control design process. As definitions for use in this study, a detention facility is designed for the collection and temporary storage of stormwater to provide for treatment with subsequent gradual release of the stormwater. A retention facility is designed to prevent the discharge of a given volume of stormwater runoff by complete on-site storage. These definitions are now being used with increased frequency by urban hydrology specialists in Florida.

A detention facility will have an outlet designed to release stormwater at controlled rates from some defined rainfall for the design drainage area until full draw down occurs near the end of the design period. A retention facility has no controlled outlet but extends the draw down period by percolating stormwater runoff into the soil. In both cases, the effective stormwater containment capacity of each facility is based upon an available containment area above the height of the seasonal high water table conditions for the esign drainage area.

The focus of most research on urban stormwater detention/retention facilities has been oriented towards their effectiveness in reducing the impacts of pollutants in stormwater runoff. Reducing the impacts of pollutants in stormwater runoff through detention/retention is an important consideration for justifying the use of these types of facilities. This purpose applies to the entire Moultrie Creek watershed.

Stormwater detention and retention facilities can be built in a wide variety of forms. They can be built to replicate natural depressions characteristic of an area. In developments near significant upland natural areas, it may be possible to divert some stormwater into natural depressions. Depressional areas can be constructed adjacent to natural drainageways or depressions to augment the vegetative environment of the natural areas. Overflow channels in developments can be built to simulate the characteristics of natural drainageways. They can be part of golf courses, parks, and constructed semi-natural woodlands. They can be slightly depressed areas of lawns, or gardens on individual properties. They can be designed as extensions to existing ponds or lakes with controlled release structures. Stormwater storage areas can be well landscaped earthen areas of almost any description or they can be concrete boxes simply built to hold rainwater. Stormwater can be retained or detained on the roofs of buildings, in containers constructed alongside buildings, or in galleried or entrenched areas under parking lots and driveways. All of these practices are technically possible.

The design of stormwater detention/retention facilities requires engineering evaluations of probable impacts upon collector drainage systems and receiving streams. The Engineering Department must have a reasonably clear understanding of the water carrying capacities of the larger systems into which storage facilities gradually release stormwater. Collector systems in low water table areas will be designed to provide for ground water recharge while accepting controlled release stormwater from a system of smaller storage facilities. In high water table areas, collector systems will drain to larger storage facilities before releasing stormwater to receiving streams, natural drainageways, or natural depression areas.

Maintenance Considerations

Surface water containment facilities require maintenance in order to retain the effectiveness of their intended functions. Stormwater detention/retention facilities need to be cleaned periodically. Numerous examples are now apparent of facilities constructed below seepage zones permitting extensive growths of cattails and related vegetation. Cattails grow prodigiously in saturated soils, and their detrital materials quickly accumulate. Where allowed to become established, expanses of cattails quickly reduce the effective storage capacities of open containment facilities.

Vegetation growth in constructed detention/retention facilities is to be expected, and the facilities must be sized on the basis of the expected reduction in capacity due to detrital and sediment materials buildup over a projected timeframe between clean out periods. Additionally, the entities responsible for maintenance of these facilities must be determined prior to establishment. Access and adequate right-of-way for maintenance and inspection equipment also must be part of facility design. Finally, measures for assuring that maintenance actually will be performed are needed.

Various types of exfiltration procedures have been used for distributing stormwater. Exfiltration techniques include buried perforated storm drains surrounded by highly permeable material that would allow rapid water percolation. Experience shows that the silts and clays associated with the fine sands typically found in St. Johns County are easily eroded and are carried with high velocity flows of stormwater. These materials quickly plug storm sewer drain perforation locations and the surrounding exfiltration material. Because storm sewers are buried, inspection is usually not possible and maintenance of perforation locations in the sewer lines is not practical. When these facilities cease to function effectively, lower property owners can be subjected to unwarranted discharges of stormwater from higher property owners.

Exfiltration facilities include French drains and all similar techniques. Use of these methods require periodic maintenance, and their design must accommodate these routine needs. Wide variety in the design of containment systems is possible, and their use is practical when designed to permit easy and periodic maintenance. Buried storm sewers intended for exfiltration purposes cannot be inspected easily, cannot be effectively maintained as an exfiltration system, and will not be permitted.

Example Design Concepts

A one acre parcel of land is an area with 43,560 square feet. A one fourth acre parcel contains 10,890 square feet. One inch of water distributed across a one fourth acre parcel is equivalent to 907.5 cubic feet of water. This volume of water can be contained in a shallow depression one foot deep, 10 feet wide, and 100 feet long. One side of a typical one fourth acre lot is often about 100 feet long, and a typical drainage easement on a parcel is 20 feet wide. A one inch storage requirement can be provided for by property owners with little modification to existing subdivision regulations. The one inch containment requirement can be met through a single shallow swale or it can be met through very shallow depression contoured areas within lawn expanses. It also can be met by constructed containers of any configuration.

In subdivisions, road rights-of-way, sidewalks, and normal stormwater systems typically use between one fourth and one third of the total pre-subdivided parcel. On the basis of a one acre parcel subdivided into three building lots, the developer would have to provide for the one inch containment equivalent to one fourth acre as part of the total infrastructural system. Numerous techniques can be devised at moderate costs for accomplishing this containment criteria. For larger subdivisions, numerous widely dispersed containment areas designed as part of the landscape provide the greatest benefits for ground water recharge. Much of the cost for constructed open space areas (recreation areas, parks, woodlands, lawn expanses, flower gardens, and entranceways) can be designed so that the composite of all areas are equivalent to the one inch stormwater volume criteria for the total parcel.

Natural Depressional Areas

Potential Uses for Stormwater Containment

Natural depressional areas may be useful for stormwater storage under specific and controlled conditions. When these areas contain wetland vegetation and are classified as significant natural resource areas, acceptable stormwater loading rates will have to be determined. Existing wetland vegetation exists in specific areas due to present climatic conditions and the resulting natural hydroperiod regime. The hydroperiod regime consists of a natural rise and fall of water on a periodic basis within the locality with desirable wetland vegetation.

The natural hydroperiod of specific depressional areas with desirable wetland vegetation is difficult to determine with any degree of precision. Depressional areas in the Moultrie Creek watershed typically have poorly defined boundary conditions; the land surface slopes towards adjacent uplands very gradually from low points within depressional areas.

Technical determination of boundary areas can be made when an acceptable high water elevation for desired wetland vegetation protection for a specific area is determined. The acceptable high water elevation determination is a judgmental decision. A typical practice is to look for evidence of annual high water marks and vestiges of higher water marks on woody vegetation. Once the field evidence establishes preferred high and low water heights, a survey can establish the controlling water elevation and range of acceptable elevations for that depression.

Survey procedures then can establish the land elevation of acceptable high water conditions and the cross sectional character of the depressional area containing the desired wetland vegetation. Available aerial photogrammetry and spatial analysis techniques (geographic information system procedures) then can be used to delineate the area encompassed within the specified elevations of the high water condition area.

The next step requires the determination of the areal extent of the natural watershed draining to the depression of concern. For smaller depressions a volumetric analysis can provide an estimate of the volume of runoff water supplied to the depression from storms of specific return frequencies. This analysis will establish the height of water rise (water stage) to expect in the depression from some design rainfall and the resultant approximate expansion of water surface area of the depression.

Using available evapotranspirational data and infiltration rates for the soil conditions characteristic of the depression, an average surface water recession rate can be established for the design rainfall condition. The recession rate data establishes time durations expected for the surface water to remain at specific water stages and the total length of time required for the water surface to fall to some specified elevation.

Once these data are available, a judgment decision must be made to estimate the maximum height and duration of flooding that would be acceptable without causing significant injury to the desirable vegetation. The comparison of this judgmental decision and the natural runoff water estimates will determine the volume of additional water under given storm conditions that could be supplied to the depressional area.

Legal Considerations

Some of the major depressional areas in the Moultrie Creek watershed (examples are Cowan Swamp and Trestle Swamp), have been parceled and are now in multiple private ownership. A number of residences have been constructed on platted parcels within some natural depressional areas. Care must be taken when considering the discharge of stormwater into depressional areas to guard against injuring other landowners. The legal implications of modifying the natural flow of water to large natural depressional areas in multiple ownership are complex. The lower infiltration rates to be expected in depressional areas due to natural soil matrix characteristics and naturally high water table conditions contribute to prolonged periods of natural flooding in these areas. The use of depressional areas held in multiple ownership cannot be recommended as receiving areas for increased stormwater discharges until all property owners are in agreement with the proposed action (As an initial reference on legal ramifications, see Maloney, 1980).

6

WATER LOSSES

EVAPOTRANSPIRATION

Evapotranspiration (ET) is the collective term applied to the combined effect of direct evaporation of water from land and water surfaces to the atmosphere and the transpiration of water from plants through their respiration processes. The concept of evapotranspiration is well understood, but estimation of the amount of water returned to the atmosphere by this process can only be roughly approximated. Too many highly variable factors influence evaporation and transpiration rates, and the unique characteristics of every watershed prevent easy analysis of actual evapotranspiration conditions at any given locality.

The evapotranspiration process requires energy, and the rate at which the net process can function varies daily and seasonally at any location according to net solar radiation received by soil, water, and plants. Direct evaporation from soil surfaces also varies according the wetness of the soil surface. Saturated soils will permit more evaporation than dry soils, and soils totally dry to depths exceeding their capillary rise ability will permit essentially no evaporation. Unshaded shallow water areas permit the maximum evaporation. Transpiration from plants varies according to plant species throughout the annual growth cycle of each species. Plants adapted to dry or xeric conditions can conserve water and transpire less than plants adapted to wet or hydric environments.

Within the Moultrie Creek watershed, less evapotranspiration can be expected to occur in those localities with excessively drained soils, low water tables, and coverings of sand pine, scrub oaks, and similar vegetation adapted to dry conditions. Increased evapotranspiration can be expected in the flatwoods and drainageway soil areas within the watershed. The maximum evapotranspiration can be expected to occur within shallow water bodies and upland depressions during the periods when inundation extends to the edges of these areas.

Evapotranspiration is maximized during the summer daytime periods immediately following rainfalls. The sun heated soils permit rapid evaporation to occur. The higher summer air temperatures also permit the atmosphere to absorb and hold more moisture in vapor form before releasing it again as rainfall.

The National Weather Service has conducted studies to develop criteria for estimating potential evapotranspiration for any locality within the United States. An Evaporation Atlas for the Contiguous United States has been prepared based upon the national network of pan evaporation stations. The National Weather Service methods are used in this study to express the approximate potential evaporation from a shallow water surface and the potential evapotranspiration to be expected to occur from a vegetated surface with an unlimited supply of water.

Previous research had established that net radiation received on the earth's surface is dominantly influenced by latitude and altitude. Evaporation summary data for Gainesville (altitude 100 feet) and Lake City (altitude 200 feet) were used to establish an estimate for the Moultrie Creek watershed (altitude 30 feet). The mean of the summary data for Gainesville and Lake City was used to approximate daily and monthly potential evapotranspiration conditions in the Moultrie Creek watershed. These daily and monthly potential evapotranspiration estimates appear in **TABLE 6-1. MOULTRIE CREEK WATERSHED POTENTIAL EVAPOTRANSPIRATION.** St. Augustine is located at a latitude 12 minutes to the north of Gainesville and 22 minutes to the south of Lake City. Due to the minor pan evaporation data differences between the two stations, developing a weighted average would not have meaningfully improved the estimate for St. Augustine.

The potential evapotranspiration estimates shown in Table 6-1 would apply primarily to areas with shallow surface water conditions and to vegetation adapted to saturated soil conditions. Vegetation adapted to saturated and flooded soil conditions is now generally classified as wetland vegetation. Wetland vegetated areas remove significantly more water to the atmosphere through evapotranspiration than upland vegetated areas.

Numerous theoretical methods have been devised over the years to provide useful potential evapotranspiration estimates for commercially important vegetation species. These methods have been developed largely to estimate potential evapotranspiration from land areas and transpiration from plants to identify the optimum amount of water to be applied or that would be needed for maximum production. The Florida Institute for Food and Agricultural Sciences (IFAS) has under-

TABLE 6-1

MOULTRIE CREEK WATERSHED
POTENTIAL EVAPOTRANSPIRATION

MONTH	AVERAGE DAILY (Inches)	AVERAGE MONTHLY (Inches)	PERCENT OF TOTAL
JANUARY	0.08	2.48	4.9
FEBRUARY	0.10	2.80	5.5
MARCH	0.14	4.34	8.5
APRIL	0.17	5.10	10.0
MAY	0.20	6.20	12.2
JUNE	0.19	5.70	11.2
JULY	0.18	5.58	11.0
AUGUST	0.17	5.27	10.3
SEPTEMBER	0.15	4.65	9.1
OCTOBER	0.12	3.60	7.1
NOVEMBER	0.09	2.70	5.3
DECEMBER	0.08	2.48	4.9
TOTAL		50.90	100.0

Source: Derived from criteria in Evaporation Atlas for the Contiguous 48 United States, NOAA Technical Report NWS 33, National Weather Service, National Oceanic and Atmospheric Administration, June 1982, based upon evaporation data for Gainesville and Lake City, Florida.

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taken a series of studies for these purposes. These studies provide useful guidance for understanding potential evapotranspiration as the amount of water lost to the atmosphere by evaporation and transpired by plants in given localities when the water necessary for the plants is supplied. By comparing these estimates with average monthly rainfall data or observed rainfall, agriculturalists can estimate the net irrigation requirements for maximizing crop production.

Field studies oriented towards the measurement of potential evapotranspiration also have been undertaken for many crops. One study with useful guidance for this analysis (Stewart, 1967) measured the monthly evapotranspiration of St. Augustine grass over a five year period at the Plantation Field Laboratory near Fort Lauderdale. The plantings were observed under normal local rainfall conditions but with saturated soils maintained at depths of 12 inches, 24 inches and 36 inches. The average annual evapotranspiration (ET) amounts resulting from this study were: 12 inch water table = 43.68 inches ET; 24 inch water table = 42.77 inches ET; 36 inch water table = 42.05 inches ET. The mean evapotranspiration was 42.84 inches with ET amounts varying monthly from 1.92 inches in December to 4.81 inches in July. The findings of this study illustrate perennial upland vegetation requirements in the Fort Lauderdale area and the more general effects of lowered water tables on evapotranspiration rates.

While the monthly ET rate for St. Augustine grass in St. Johns County may be slightly less than in Ft. Lauderdale due to cooler winter temperatures in north Florida, the summer-to-winter difference in ET rates (about 1.9 inches in December and 4.8 inches in July) is significant to water management in the Moultrie Creek watershed. High water tables occur in St. Johns County during the winter months. This condition can be accounted for, in large part, by cooler temperatures and the dormancy and slower growth of perennial vegetation during the winter months. These factors result in lower ET water losses to the atmosphere during the winter months.

Potential evapotranspiration is a measure of evaporation and transpiration from vegetated areas when all the necessary water is provided from maximum plant growth. Potential evapotranspiration estimates do not reflect the actual evapotranspiration conditions to be expected in watersheds. The highest land areas in a watershed may have very dry surface soils, deep water tables, and xerophytic vegetation. These locations would have very low actual evapotranspiration water losses. Natural upland depressions with ponds, swamps, and marshes; hydric soils; and hydrophytic vegetation have high evapotranspiration rates. High evapotranspiration rates also occur along stream flood plains and around shallow water bodies. As the antecedent period between rainfalls becomes extended, evapotranspiration water losses are highest immediately following a rainfall and gradually diminish until the next rainfall. For water management purposes, it is important to have an understanding of the actual evapotranspiration characteristics of each watershed.

Some efforts have been taken by the United States Geological Survey to establish general information on actual evapotranspiration for large drainage basin areas by comparing estimates of rainfall with measured runoff. The term applied to these estimates is areal evapotranspiration. From the United States Geological Survey information (Hughes, 1976) and a conceptual modeling effort (Morton, 1976), areal annual evapotranspiration at the north Florida border was estimated at 37.4 inches and in central Florida at 42 inches. From these data, a general areal evapotranspiration estimate of 38 inches annually for the Moultrie Creek watershed and St. Johns County may be assumed. Disaggregation of the above annual areal evapotranspiration estimate to monthly values for use in hydrological analyses can use the "Percent of Total" column data presented in Table 6-1 applied to 38 inches to establish areal average monthly and areal average daily evapotranspiration rates.

RUNOFF

Concept

Runoff is rain water moving as surface water flow from one location to another following a rainfall after the immediate localized demands of soils, vegetation, and the process of evaporation are met. Runoff can be increased by positive drainage programs, compaction of soils by urban land uses and the construction of impervious areas, removal of natural water storage areas, disturbances of surface soils containing long–term accumulations of detrital materials, and removal of high water utilization vegetation. Reduction in runoff can be accomplished through controlled drainage programs, maintenance of natural vegetated areas and management practices to maintain soil in permeable conditions, creation of additional water containment areas, and by constructing natural wetlands. Public policy determines which of the above actions are acceptable practice. Engineering design of works to provide for development needs within the public policy framework then can be applied.

Drainageways

Throughout the upland areas of the Moultrie Creek watershed, broad, flat areas serve as sheet flow drainageways when unusually large rainfalls fill adjacent depressional areas. The Soil Survey information in Figure 4–2 generally identifies natural drainageway localities. Over time, repeated stormwater runoffs from adjacent higher lands have carried sediments and detrital materials into the drainageways giving the soils a different color and slightly changed constituent characteristics. In many cases, only a few feet in land elevation mark the difference between sheet flow drainageways and adjacent knolls. Under natural conditions, these areas provide some level of control of runoff flow from one depressional area to another.

Development within the Moultrie Creek watershed is ongoing, and property owners have ditched and drained the lands through and across natural drainageways. Parcels have been platted over the years in gridiron fashion with essentially no consideration for natural drainageways or depressional area conditions. Scattered lots subsequently have been developed within natural drainageways with associated property perimeter ditching and draining efforts practiced. Property owners in these areas, understandably, generally desire improved drainage programs.

The gridiron platting and resulting development process has altered the natural runoff to depressional areas that public policy normally would now consider as significant natural resource areas. The long-term maintenance of significant natural resource areas can only be assured when they are able to receive runoff waters periodically in the volumes necessary for their sustenance.

Drainageway Management

Once significant natural resource areas are identified and their runoff water supply needs are estimated, engineering works can provide for designed systems that either supplement or replace original natural drainageways. Within this stormwater management system framework and other conditions essential for protecting the health and welfare of citizens, property owners can undertake development actions.

Following development of public policy and general runoff system design criteria, private property owners will be able to construct systems in any configuration that meet governmental criteria and are not detrimental to the rights of adjacent property owners. Where private drainage projects already exist, some remedial action by government may be necessary with attending legal ramifications. Where lands have been platted but remain undeveloped, other governmental actions may become necessary. The greatest flexibility for preserving, supplementing, or replicating natural drainageways are in those areas not yet platted. In these areas, the essential functions of natural drainageways can be determined by government or as a private development requirement. The necessary system can be designed to preserve the effectiveness of significant natural resource areas likely to be impacted by development actions within the proximity of the natural drainageway.

Controlled Drainage Criteria

A controlled drainage system will provide for the maximum exfiltration from the system and infiltration into the ground water table. It will be designed to retard the effects of erosion and the transport of the silts and clays associated with the sandy soils found throughout St. Johns County. Also, by controlling fine organic materials the system confines pollutants and protects water quality. It will also provide for the rare rainfall from major storms. A system channel with a controlled flow capacity will be designed to provide for stormwater from rainfalls expected on the 25 year 24 hour return frequency basis, or a total of about 8.8 inches for the rainfall event. Finally, any system considered for operation and maintenance by the County, will be designed with overflow areas to accept the 50 year, 24 hour rainfall event runoff, or 10 inches of rainfall, with all structures designed to maintain structural integrity under the same event condition.

Silts, clays, detritus, and very fine sandy soils become suspended in water flowing at rates in excess of 1.5 cubic feet per second. Broad channels, distributed flow channels, and the use of low flow water control structures providing effective flat bottoms or near zero profile slopes between structures for low and intermediate flows can reduce flow rates and eliminate erosion from annual and higher rainfall condition storms. Construction of downstream weir crests and inverts of culverts at raised elevations to create an effectively flat channel will provide sediment control to trap initial construction disturbed very fine sands, silts, and clays to weir crest levels.

Exfiltration estimates of open channel bottoms will be based upon potential infiltration rates of the sediment fines trapped within the drainage channel and the height of the channel bottom above average annual high water table conditions for the parcel proposed for development. Drop boxes, inverts of culverts, and sills of weirs will be designed to maintain required flow rates.

While channel depths constructed to the lower point of annual natural water table conditions may become necessary, maximum exfiltration will occur when the channel is constructed at an elevation above the annual natural high water table conditions. Where the lower depth channels are necessary, outflow points from the system will be controlled by raised culverts and weirs to elevations determined by the Engineering Department to assure that overdrainage will not occur.

Channels will have outfall structures at final discharge points to control discharge flows. All systems will be designed for zero discharge from the first one inch of runoff expected from the drainage area (see Tables 2-1 and 2-2). After retaining the first one inch of rainfall, a maximum discharge equivalent to about two inches of controlled runoff per day from rainfalls of up to three inches per day would provide for normal rainfalls expected annually (see Table 2-3). An additional discharge capacity of three inches per day of controlled runoff from the still larger and the extremely rare rainfall events will accommodate flood protection needs while providing controlled flow protection to the County infrastructure and the natural environment.

The Engineering Department will further evaluate the possibility of using simple volumetric analyses of expected runoff for smaller areas. The use of the above controlled flow concepts will permit the use of simpler calculation methods for achieving acceptable water detention/retention for recharge and controlled discharge purposes. For example, the Rational Method for estimating runoff peak flows and the Rational Mass Curve Method for estimating required storage volumes can be simply calculated. These methods provide reasonable approximations useful for small area analysis. As the size of the area becomes larger, these calculation methods progressively overestimate runoff and storage volume requirements. From the County's management perspective, the use of these methods to determine detention/retention facilities, controlled flow conveyance systems, and runoff control structures results in increased system capacities. The use of these simpler techniques benefits the public due to the conservativeness of the resulting controlled flow systems and the simplified permit application review process. The use of these simpler computation methods cannot be recommended for the design of large area uncontrolled-flow discharge systems. From a developer's perspective, these simpler methods reduce the costs of analyses as compared with more complex evaluation procedures, but their use for large areas results in increased construction costs due to system over design.

Natural Streams

The riverine (above tidewater) part of Moultrie Creek and its tributary stream courses receive and discharge the runoff waters to tidewater. This fresh water mixes with ocean water to form estuarine waters of progressively increasing salinity in the lower course of the Moultrie Creek to its mouth at the Matanzas River.

A significant part of riverine flow is derived from ground water seepage. Rain water infiltrating into the ground flows from high water table areas and emerges as seepage along stream courses. Stream flow derived from seepage is termed base flow. Rain water infiltrating the ground can provide seepage or base flow water to the riverine part of Moultrie Creek for several weeks following a heavy rainfall. The length of time that base flow contributes to stream flow is dependent upon the replenished or maintained height of the water table in adjacent upland areas.

During extended drought periods, base flow in Moultrie Creek can cease. Review of The United States Geological Survey maintained stream discharge gage at State Road 207 (ID 02246900) indicates an increasing number of days with little or no flow in recent years. This condition reflects decreased rainfall amounts and the effects of development with uncontrolled storm drainage in the watershed above the gage.

Documented Stream Flows

The stream gage at State Road 207 (ID 02246900) measures flow from a 19.8 square mile area of Moultrie Creek watershed (49 percent of the watershed) above the gage. The datum of the gage is 14.24 feet above the National Geodetic Vertical Datum of 1929 (about mean sea level), an elevation fifteen or more feet lower than the elevation of the average land surface in the vicinity of the gage. The information referenced below is based upon the time period from October 1961 through September 1988.

The minimum water surface elevation in the record was 1.84 feet above the datum on July 15, 1981. Zero stream flow occurs when the gage height (water surface) is less than about 2.2 feet above the datum. The highest gage height recorded for the 27 year record period was 9.16 feet above the datum on September 21, 1969, when the maximum discharge of 860 cubic feet per second (cfs) occurred.

During the October 1987 through September 1988 period or the 1988 water year, 60 percent of the days recorded flows of less than 1 cfs and numerous days in the months of October and November 1987 and June and August 1988 recorded zero flows. Low flows of 0.06 and 0.05 cfs were recorded during the months of July and September 1988. The discharge data for the 1988 water year reflected an average daily flow rate at the gage of 15.2 cfs. This average value represents a 1988 water year runoff from the watershed above the gage equivalent to 10.4 inches of watershed rainfall. The 27 year average daily flow at the gage is 17.7 cfs, equivalent to 12.14 inches of rainfall.

Provisional data for a second stream gage (ID02247012) on the Moultrie Creek tributary (Tributary No. 4 in the Federal Emergency Management Agency Flood Insurance Study) at State Road 207 were also reviewed. This gaging station was established in March 1988. The provisional data showed zero flow periods during the 1988 water year similar to Moultrie Creek. The maximum discharge recorded was 41 cfs in November 1988. Only three days indicated flows in excess of 10 cfs. Discussions with a United States Geological Survey representative revealed that water diversions may be occurring upstream of the gage as a result of private development actions.

Stream Discharge Characteristics

The stream discharge characteristics of Moultrie Creek were reviewed. Data were assembled from daily stream flow records to establish the runoff characteristics from a variety of storms. The available data indicated that stream flow at the State Road 207 gage typically peaked approximately twenty- four hours following a rainfall event. Initial runoff discharges are considered to reflect a three to four day period following rainfalls. The stream gage data indicates that discharge volumes recorded prior to an event typically return to the pre-event volumes within about four weeks following the event. These findings suggest that initial runoff ends within roughly four days following an event, and a gradually declining and delayed runoff and base flow continues for several weeks following an event.

TABLE 6-2. ST. AUGUSTINE RAINFALL AND MOULTRIE CREEK DISCHARGE MARCH 1 THROUGH MARCH 26, 1980 presents data for a March 1980 rainfall for St. Augustine and March 1980 stream discharge data (Station ID 02246900) for the 19.8 square mile drainage area of Moultrie Creek upstream of State Road 207. The primary rainfall occurred on March 9 and 10, amounting to 4.12 inches. This was a minor annual rainfall, not even equivalent to the two year, two day expected rainfall. The period preceding the rainfall was six days, including March 3 with a trace of rainfall recorded. During the event period from March 3 to March 27, when a new rainfall event occurred, three rainfalls events occurred. The average antecedent period between the rainfall events was five days.

The stream gage data shows a progressive decline from March 2 through March 8. A slight increase occurred on March 9, with a major increase in discharge on March 10. The discharge peaked on March 11, with a rapid decline through March 13, indicating completion of the initial storm run-

TABLE 6-2

ST. AUGUSTINE RAINFALL AND MOULTRIE CREEK DISCHARGE MARCH 1 THROUGH MARCH 26, 1980

Day	Daily Rainfall (Inches)	Discharge Cubic Feet Per Second
1	0	8.7
2	0.15	8.9
3	Trace	8.1
4	0	7.4
5	0	7.0
6	0	6.6
7	0	6.2
8	0	5.8
9	0.65	7.7
10	3.47	157.0
11	0	269.0
12	0	166.0
13	0.18	120.0
14	0	93.0
15	0	71.0
16	0	59.0
17	0	52.0
18	0	45.0
19	0	39.0
20	0	35.0
21	0.3	32.0
22	0	28.0
23	0	24.0
24	0	21.0
25	0	19.0
26	0	16.0
	Total	1246.0
27	Beginning of New Rain Event	

off. Of the total volume of water discharged between March 10 and March 26, the four day period of March 10 through March 13 accounted for 57.1 percent of the total. The remaining 42.9 percent of the stream flow would be representative of delayed runoff and seepage flows.

WATER LOSS IMPACTS

A perspective of the significance of water loss factors is provided by the following example analysis. The volume of water represented by the 4.6 inch rainfall occurring between March 9 and March 26, 1980, on the 19.8 square mile Moultrie Creek watershed approximates 4857.6 acre feet. The total discharges noted in Table 6-2 for the March 9 to March 26 period are equivalent to about 2471.3 acre feet of water or about 50.9 percent (2.34 inches) of the total 4.6 inches of rainfall received by the 19.8 square mile watershed. Areal evapotranspiration at 0.105 inches per day for that same period represents about 1.785 inches of rainfall. Runoff and evapotranspiration can account for all but 7 percent of the rainfall during the 17 day period.

Had another storm not occurred on March 27, the daily stream discharges would have continued to recede slowly each day for about 10 more days before declining to 5.8 cubic feet per second, the discharge recorded on March 8 and the day before the March 9 rainfall. Estimated discharges for the additional 10 days would approximate about 196 acre feet of water discharged to the stream essentially as seepage. The total runoff, including base flow for a 27 day period could account for about 55 percent or 2.53 inches of the rainfall received on the watershed during this example event. Areal evapotranspiration for a 27 day period in March would be approximately equivalent to another 2.84 inches of the rainfall. Without another rainfall, the entire 4.6 inches of example rainfall can be accounted for in evapotranspiration and runoff, and the continued water losses would result in a deficiency of 0.77 inches of rainfall. The process of rainfall, continual evapotranspiration, runoff, and a three to four week period of delayed runoff and slow seepage providing base flow to the stream, as exemplified in Table 6–2, is ongoing.

Evapotranspiration is a highly variable and an essentially uncontrollable process. Vegetated areas with saturated soils evapotranspire water at a rate of about 50.9 inches per year in St. Johns County. An average, estimated actual, or areal evapotranspiration rate of 38 inches per year is more representative of the varied conditions on the watershed. The United States Geological Survey estimates that runoff accounts for about 12 inches of annual rainfall. For an average rainfall year of 53 inches, only 3 inches of rainfall remain for ground water recharge or water use if a balance between rainfall and water use is to be maintained.

The practical significance of the need to retain more water on the land for recharge can be illustrated through the following example. If a family of four uses 400 gallons of water per day, they will, in one year, use 146,000 gallons of water. One acre inch of water is equivalent to 27,155 gallons, and one inch of water per square mile is equivalent to 17,380,000 gallons of water. Therefore, 119 families, each with four people, would use one inch of rain water that has managed to infiltrate into a one square mile land area and recharge the surficial aquifer.

As another example, assume 20,000 people, at an average per capita use of 100 gallons of water per day, are supplied from a well field withdrawing water from the surficial aquifer. Assume also that three inches of rain water could infiltrate into the soil and recharge the aquifer. The 3 inches of recharge would be required from a land area of about 14 square miles for the recharge to balance the water use. This simple example assumes that three inches of rainfall could be saved and allowed to infiltrate and recharge the surficial aquifer with no additional losses of evapotranspiration, runoff, or agricultural or industrial withdrawals from that same supply. The example also assumes that the average annual 53 inches of rainfall will occur. Finally, the 100 gallons per capita per day water use estimate is used here for simplification. Urban area estimates of per capita daily water uses are typically higher; an estimate of 133 gallons per capita per day (gpcd) is widely used for St. Johns County.

7

FLOOD PRONE AREAS

NATIONAL FLOOD INSURANCE PROGRAM DATA

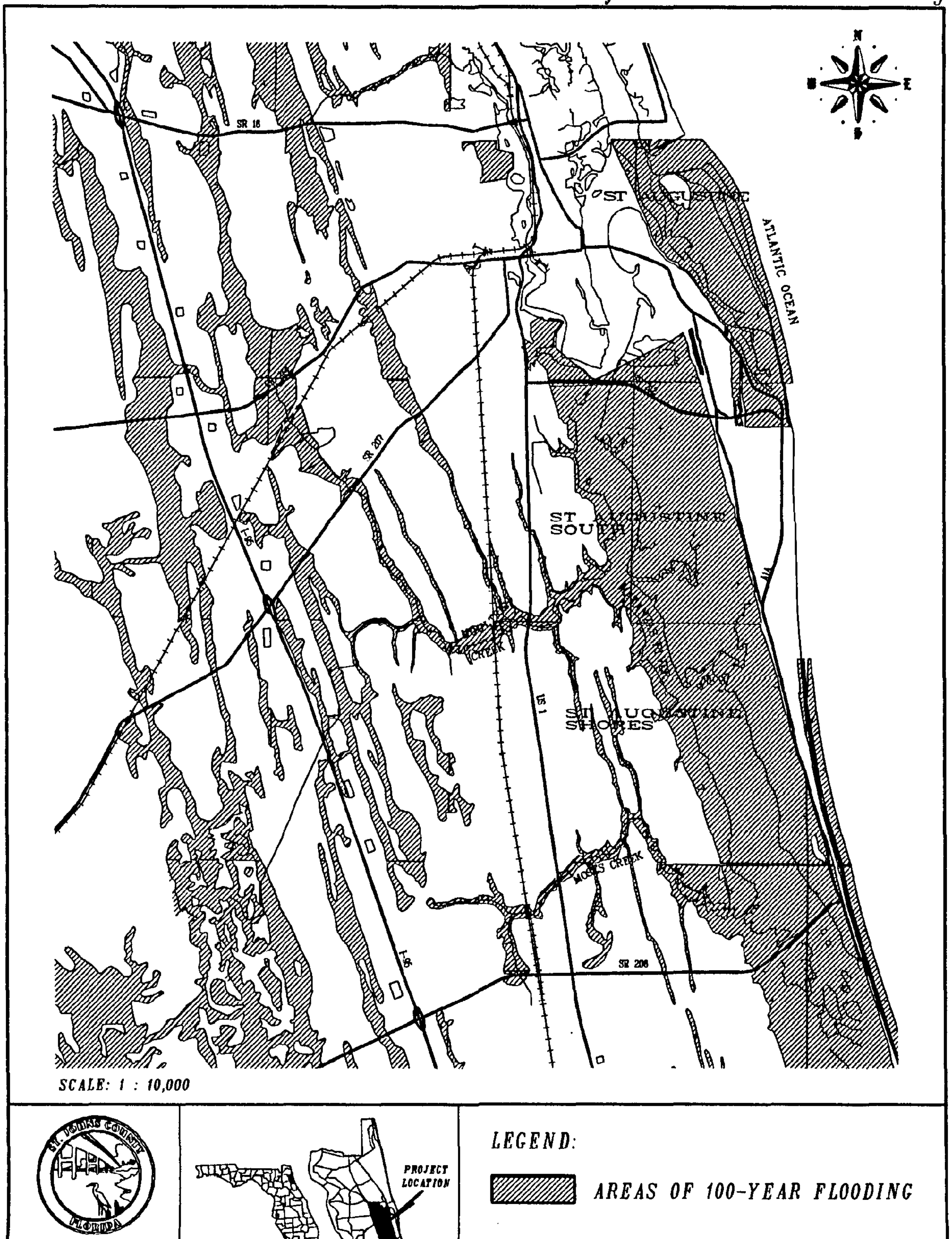
The Federal Emergency Management Agency completed a flood insurance study for the unincorporated areas of St. Johns County (Community Number 125147), dated September 18, 1985. This study includes peak discharges, floodway, and base flood elevations for Moultrie Creek and three tributaries. The three tributaries studied drain from the north in the developing parts of the Moultrie watershed between Moultrie Creek and the Matanzas River. This study and companion Flood Insurance Rate Maps establish a 100-year flood elevation (base flood elevation) along the studied stream courses. **Figure 7-1. Flood Hazard Areas Subject To 100-Year Flooding,** depicts the special flood hazard areas subject to 100-year flood conditions as determined by the Federal Emergency Management Agency.

Tributary #1 drains a small 1.5 square mile area located east of State Road 5A. The mouth of this small stream is located immediately west of Shore Drive. The 100-year flood elevations along this stream range from 8 feet NGVD at the stream mouth to 25 feet NGVD at Lewis Point Road. Upstream of Lewis Point Road, a generalized area is depicted on the Flood Insurance Rate Maps identifying a Zone A, a special flood hazard area with no base flood elevation determined.

In those cases where the Federal Emergency Management Agency does not establish base flood elevation, the interagency agreement with the local government requires that the local government establish an interim base flood elevation applicable to local development actions. Zone A locations in the Moultrie Creek watershed are typically upland depressions, natural drainageways, and some flatwoods soils area that would be subject to shallow flooding under a storm of an intensity capable of producing a 100-year return frequency flood.

Tributary #2 drains a small area on the south side of Moultrie Creek that was not studied. Tributary #3 drains a

Figure 7-1. Flood Hazard Areas Subject To 100-Year Flooding



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ST. JOHNS COUNTY ENGINEERING DEPARTMENT - GEOGRAPHIC INFORMATION SYSTEM small 0.7 square mile area on the north of Moultrie Creek between the Florida East Coast Railroad and State Road 5A. Base flood elevations ranging from 9 feet NGVD at tidewater to 21 feet NGVD at a point 5800 feet upstream of the tributary's mouth. A generalized area upstream of 5800 feet along the tributary's stream course is delineated as a Zone A.

Tributary #4 drains a 4.1 square mile area located immediately to the west of Tributary #3. Delineated base flood elevations range from 9 feet NGVD at tidewater to 35 feet at State Road 207. Upstream of that location, a generalized Zone A area is delineated.

On Moultrie Creek, flood elevations are provided from tidewater to State Road 214. The following are base flood elevations in feet above NGVD obtained from stream profile data: Osceola Trail, 10.7; State Road 207, 25.8; Lightsey Road, 30.2, Florida East Coast Railway, 32; and State Road 214, 34.2. An extended area upstream of State Road 214 is delineated as a Zone A.

EVALUATION CRITERIA

Construction of roads and inhabited buildings above the 100--year flood elevation will be required. The National Flood Insurance Program has established the 100-year return frequency flood condition as the base elevation for insured habitable structures. The need for emergency access to properties, the protection of the public from injury resulting from flooding of roads, and the obligation of local government to provide for the safe movement of people on public roads dictates the need to establish the 100-year return frequency flood as the elevation above which roads should be constructed.

In those parts of the watershed where National Flood Insurance flood information is available, the elevations established through that program will be used. In those areas where the base flood elevation must be estimated, the following procedure will be used.

The 100-year return frequency 24-hour rainfall (12.8 inches) will be used. The normal annual high water table condition and the SCS Runoff Curve Number applicable to the area included in the proposed development will be used to establish a soil infiltration runoff reduction estimate. Large developments encompassing many different water table and soil conditions will be segmented into representative soil characteristic subareas.

The planned stormwater containment facilities for the proposed development will be used to estimate initial abstraction land storage and retention requirements. The proposed channels and other components of the development stormwater management system will be used to establish rainfall depth reductions to be expected from runoff during and immediately following the rainfall event. Open land areas of the parcel or surface water storage areas sufficient to detain or retain the remaining rainfall will be estimated.

All parcel land elevations above the maximum water elevation required to contain or otherwise manage the 100-year rainfall will be considered as above the base flood elevation. All public roads will be constructed with road surfaces above the base flood elevations. Access to public facilities, and all structures used as residences and as established locations of employment will be constructed with habitable or occupied first floors above the base flood elevation.

8

ATLANTIC COASTAL RIDGE

WATER RESOURCE STUDY CRITERIA

The information assembled provides guidance for evaluating hydrological analyses conducted in the Moultrie Creek watershed. In addition to the review of existing information previously presented, **TABLE 8-1. GUIDELINE HYDROLOGICAL CRITERIA FOR THE ATLANTIC COASTAL RIDGE ST. JOHNS COUNTY, FLORIDA** has been prepared as initial guidance for application to the Tillman Ridge part of the Moultrie Creek watershed. Until rainfall gage data becomes available for the interior part of St. Johns County, these data provide information that may be applied to all of the Atlantic Coastal Ridge portions of the County.

The monthly rainfall estimates presented in Table 8-1 are composites of monthly averages obtained from the unedited or non–normalized data available for Hastings and St. Augustine. Hastings data are based upon the 1978 to 1986 record period and St. Augustine data are based upon the 1973 to 1986 record period. The reduced average monthly rainfall for July reflects decreased rainfall for that month at St. Augustine during the record period.

Because rain gaging stations are not available for the westerly parts of St. Johns County from Switzerland northward, the data presented in Table 8-1 may be applied to analyses conducted in northwestern St. Johns County. Hastings data provides guidance for the southwestern part of the County, Marineland for the southeast, St. Augustine for the central coastal area, and Jacksonville Beach for the north coastal areas. The data for these stations are generally available from the United States Weather Service. Later studies may find that a single composite set of data may be appropriate for the entire coastal portion of the County.

The average daily evapotranspiration data presented in Table 8–1 were derived from the annual estimate of 38 inches used to represent areal evapotranspiration in this study. This annual estimate was then disaggregated based upon the average

TABLE 8-1

GUIDELINE HYDROLOGICAL CRITERIA
FOR THE ATLANTIC COASTAL RIDGE
ST JOHNS COUNTY, FLORIDA

MONTH	AVERAGE RAINFALL (Inches)	AVERAGE NUMBER OF RAINFALL DAYS	AVERAGE NUMBER OF ANTECEDENT DAYS	EVAPOTRANSPIRATION MONTHLY (Inches)	EVAPOTRANSPIRATION DAILY (Inches)
January	3.2	4.8	6	1.86	0.06
February	3.4	5.0	6	2.09	0.07
March	3.9	5.6	5	3.23	0.11
April	3.4	3.8	5	3.80	0.13
May	3.5	3.9	5	4.64	0.15
June	6.7	7.9	4	4.26	0.14
July	5.8	9.3	3	4.18	0.13
August	6.8	9.3	3	3.91	0.13
September	7.3	8.5	3	3.46	0.12
October	3.6	4.8	6	2.70	0.09
November	2.3	4.6	6	2.01	0.07
December	3.1	4.9	6	1.86	0.06

Note: Slight anomalistic characteristics appearing in the average rainfall data are believed to be due to the short time frame of the database.

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monthly potential evapotranspiration values as percents of total potential annual evapotranspiration noted in Table 6-1.

The average number of rainfalls per month and the average number of antecedent days between rainfalls were developed from an evaluation of the available Hastings record (TABLE 2-2 and TABLE 2-3). These values are intended as guidance until further studies are conducted for more stations in north Florida with longer periods of records.

Additional studies are also needed using hourly rainfall data. Average Daily rainfall data do not reflect rainfall events adequately for some design purposes. Review of stations that may be representative of conditions in St. Johns County is needed, and procedures for incrementally progressing rainfall through a system of characteristic, but hypothetical, storms would provide improved criteria for evaluating storm effects. Generalized procedures are available for this purpose, but no standardized procedure is yet available that can provide reasonable assurance that the representations used are applicable to St. Johns County conditions.

Finally, studies are needed to correlate observational surficial aquifer water well log data with rainfall to establish well recovery extents following rainfalls of varying intensities and durations under existing conditions. Wells withdrawing water from different depths can be expected to recover differently. Similarly, wells penetrating differing soils matrix materials also will react differently to rainfall events. Information from this type of analysis will have to be spatially correlated with land use and natural resource areas within the theoretical recharge localities of the observational wells to establish the extent and dependability of natural recharge capabilities. The final results of these analyses will provide fundamental information on the effectiveness of differing engineered water management facility configurations. These study efforts will provide necessary information for establishing cost-effective measures and final Engineering Department criteria for basin-wide management of stormwater.

9

SIGNIFICANT NATURAL RESOURCE AREA MANAGEMENT

GENERAL

Those natural areas within the County that require special governmental management procedures have been identified as "Significant Natural Resource Areas." These areas include important wetlands of state and national concern and other natural environmental areas of importance to the well being of residents of St. Johns County. Significant natural resource areas include surficial aquifer recharge areas, riverfront areas, shorelines, water bodies, wetlands, woodlands, wildlife sanctuaries, and archaeologically important locations.

Developments permitted adjacent and near to these areas require special pre-project review. Natural conditions required to preserve these areas are to be maintained if the natural area is to remain viable and not move into a gradual process of decline. Cultural developments that may impact upon these areas also must be reviewed to determine the significance of negative impacts resulting from the development. Where possible, government guidance can be provided to property owners to assist them to undertake development efforts that could lead to the enhancement of significant natural resource areas. To be encouraged, are those private efforts to create new natural resource areas and efforts to augment or extend existing significant natural resource areas.

SIGNIFICANT NATURAL RESOURCE AREAS

Tidal Wetlands (Moultrie Creek Estuary)

General Protection Needs

The Moultrie Creek estuary and associated tidal wetlands extend for approximately five miles upstream of the river's confluence with the Matanzas River. The natural vegetation consists of seashore saltgrass, bushy sea-oxeye, glasswort, and needlegrass rush. This is an important wildlife area. The native vegetation and fauna are important links in the food chain for many sport and commercial finfish and shellfish.

The environmental health of the natural area is dependent upon continual ground water seepage from adjacent higher water table areas and fresh water discharges from Moultrie Creek and tributary streams. A primary hazard to this natural area is the introduction of pollutants and excessive sediments with stormwater discharges from roadway drainage systems and urban developments in the watershed. Excessive nutrients introduced with effluents from septic tanks and waste water treatment plants are also potential hazards affecting the balance of biological processes within the estuary.

Contamination From Roadways

A primary source of pollutants occurs with runoff from roadways. As roadway traffic loads increase with development, the practice of positive uncontrolled drainage from these roadways is introducing increasing loads of oils, greases, tars, rubber and other tire composition materials, oxides from automobile exhausts, and a host of other types of particulate matter associated with modern vehicular traffic into the estuary. The entrapment of these contaminants in retention storage facilities constructed as roadway drainage facilities is essential for preservation of the biological processes in the Matanzas River and St. Augustine Harbor estuary.

Roadway Retention Storage Catchment Benefits

No technical reason exists for avoiding the use of roadway retention storage catchments along Moultrie Creek and the Matanzas River. The natural water tables in these areas are found generally at six or more feet below ground elevation. The water holding capacity of the first four feet of soils immediately adjacent to the estuarine parts of Moultrie Creek are on the order of ten inches or more of equivalent rainfall. The permeability or rate at which the water percolates through these soils is very high. Retention basins constructed in these low or deep water table, highly permeable soils would remain dry except for short periods following the most intense rainfalls. Materials entrapped in these basins would be reduced by aerobic organisms and conservative materials (heavy metals) would electro-chemically bind to fine silts and clays washed into, or formed by reduction processes, within the catchments. When constructed above the natural high water table, catchments constructed in these areas would require very infrequent maintenance.

The extensive use of retention storage catchments throughout the low or deep water table localities also provides for the continued base flow essential for maintaining fresh water flows into the Moultrie Creek estuary. The fresh water head created by the infiltration of trapped rainfall also serves to reduce the potential of salt water intrusion into the surficial aquifer adjacent to the tidal parts of the Matanzas River and Moultrie Creek.

Contamination From Septic Tanks

St. Johns County has permitted urban development with septic tank effluent disposal along the Matanzas River and Moultrie Creek estuaries. When properly operating, septic tank drainage releases nutrient rich effluents that move with groundwater seepage into the estuaries. As long as population densities remained low, these enriched septic tank effluents with high levels of nitrogen, phosphorous, and other nutrients could be accommodated by biological processes within the estuary.

As development increases throughout the St. Augustine metropolitan area, the increasing release of nutrients from septic tanks, waste treatment plants, and natural vegetative sources can overload the natural biological nutrient processing capacity of the estuarine system. The result will become noticeable by increased vegetation growth, increased quantities and accumulations of detritus (plant remains) in shallow waters, increased buildup of resulting organic materials filling in shallow waters, increased biochemical reduction of these organic materials through anaerobic processes with resulting increases in hydrogen sulfide, methane, and similar anaerobic process gas releases; and subsequent decline in the suitability of extended areas of the estuary as food production and protection areas for juvenile finfish and shellfish.

Septic tank effluent releases pose still other problems for protection of the estuarine waters. Modern urban living has come to depend upon a host of highly toxic cleaning and other materials. Many homeowners have little concern for the biological processes that make a septic tank reduce human waste into relatively harmless sediments and a liquid, nutrient rich effluent that is released through a drain field. Household cleaners, paint products, pesticides, etc., can easily reduce the effectiveness of the system and permit the release of human waste pathogenic materials and the toxic materials in the septic tank effluents. No known process exists for readily determining the extent of misuse of septic tanks.

Septic tanks also require cleanout periodically in order to continue to function properly. As the sediments (sludges) gradually build up within the tank, the efficiency of the system declines. Eventually, very poorly treated effluents are released into the environment. No County program exists to certify to the proper operation of septic tanks.

Dredge and Fill Problems

The environmental health of tidal portions of the Moultrie Creek watershed requires the preservation of wetlands vegetation in the estuary and the biological processes associated with those vegetated areas. Construction activities in estuarine wetlands remove some vegetation. When construction actions are not extensive, reestablishment of the original vegetation can occur within three to five years following the construction activity.

Construction activities also disturb wetlands bottom materials and/or upland soils matrix materials. In the process, runoff from the land carries increased loads of silts and clays. Tidal exchange waters then carry the silts and clays from uplands and from the disturbed bottom materials to other locations within the Matanzas River and into the greater St. Augustine Harbor area. The construction related increases in suspended sediments creates turbid waters that reduce the normal biological processes within the greater estuary. In sufficient quantities, the introduced silts and clays can smother benthic organisms and destroy significant areas of sessile vegetation within the estuary.

For the continued and normal environmental health of the greater St. Augustine Harbor estuary, all construction activities likely to cause high levels of water turbidity or otherwise affect the quality of the water in the estuary must be managed to assure the minimum of short- and long-term damage from the activity occurs. Federal and State of Florida programs exist to provide protection from direct disturbances of wetlands from urban development actions.

U. S. Army Corps of Engineers Regulatory Program

The U. S. Army Corps of Engineers regulates activities in open waters and wetlands under the following four separate but related laws:

1. The Rivers and Harbors Act of 1899 which requires authorization for activities such as constructing piers, bulkheads, subaqueous pipe- lines, filling, dredging, stream channelization, and similar works in navigable waters of the United States. In response to 1968 court rulings, permit application reviews now include protection of fish and wildlife, conservation, pollution, esthetic, ecology, and general public interest;

2. The Federal Water Pollution Control Act of 1972 requiring the restoration and maintenance of the chemical, physical, and biological integrity of the nation's waters. Section 404 of the Act established the permit program to regulate discharges of dredged or filled material into waters of the United States;

3. The Clean Water Act of 1977 expanded the Corps Section 404 authority to include, but not be limited to, all coastal and inland waters, lakes, tributaries to navigable waters, wetlands adjacent to navigable waters, and certain isolated wetlands and water bodies;

4. The Marine Protection Research and Sanctuaries Act of 1972 authorizes the Corps of Engineers, under Section 103, to issue permits for the transportation of dredged material for ocean disposal.

In general, Corps of Engineer permits are required for any construction in all tidal areas channelward of mean high water lines in the Moultrie Creek estuary. Complete information on Corps of Engineers regulatory requirements can be obtained from: Regulatory Division, P. O. Box 4970, Jacksonville, Florida, 32232-0019. Telephone: 904/791-1676.

Florida Department of Environmental Regulation Permits

The Florida Department of Environmental Regulation exercises regulatory jurisdiction over dredge and fill activities in waters of the State to their landward extent. Landward extent is determined by the dominance of certain wetland indicator vegetation species defined in Chapter 17-4 of the Florida Administrative Code. The State Wetlands Protection Act of 1984 (Chapter 403, Florida Statutes) authorizes regulation of wetlands to protect and preserve water quality and preserve fish and wildlife habitat. Determination of regulatory jurisdiction is based upon an area's regular and periodic inundation, physical waterbody connections to "waters of the State," and dominance by the specified wetland indicator species. Waters of the State are rivers, streams and their tributaries, bayous, sounds, estuaries and bays and their natural tributaries, most natural lakes and the Atlantic Ocean and Gulf of Mexico to the seaward limit of the state's territorial boundaries.

The Florida Department of Environmental Regulation development action review evaluates the potential impact of a proposed project on the waters of the State. This review process is intended to assure that the project will not:

1. Obstruct or alter the natural flow of navigable waters;

2. Induce harmful or increased erosion, shoaling of channels, or create stagnant areas of water;

3. Interfere with the conservation of fish, marine resources and wildlife, or other natural resources;

4. Induce destruction of oyster beds, clam beds, or marine productivity including, but not limited to, destruction of natural marine habitats and grass flats suitable as nursery or feeding grounds for marine life.

More complete information on the Department of Environmental Regulation rules may be obtained from: Office of Public Information, Florida Department of Environmental Regulation, 2600 Blair Stone Road, Tallahassee, Florida 32301.

Florida Department of Natural Resources Review

Under the authorization of Chapter 253, Florida Statutes and in accordance with Rule 16 of the Florida Administrative Code, the Florida Department of Natural Resources (DNR) conducts the following evaluations of development actions relative to tidal portions of Moultrie Creek:

1. The water dependency of the project;

2. The setback of the project from the applicant's riparian lines;

3. The project's consistency with other policies, standards, and criteria set forth in the Florida Administrative Code Rule 16Q-21.04.

More complete information on the above regulatory procedures may be obtained from the Bureau of Beaches and Shores and the Bureau of State Lands, Florida Department of Natural Resources, 3900 Commonwealth Boulevard, Tallahassee, Florida 32303.

St. Johns County Tidal Wetland Criteria

In order to avoid duplication of regulatory measures dealing with dredge and filling of waters impacting national navigable waterways, St. Johns County shall develop review procedures incorporating the process established by the U. S. Army Corps of Engineers. Similarly, the Florida Department of Environmental Regulation's wetland protection criteria and the Florida Department of Natural Resources criteria shall be incorporated into the County review process. The primary environmental criteria of concern in the dredge and fill permitting process include:

1. The potential impact of the action on the essential and sustainable quality of waters in the County;

2. The potential effect of the action of the propagation and sustenance of wildlife, fish and aquatic plants and animals important to the food chain of commercial and sport fish and wildlife;

3. The potential impact of the action on the health and welfare of property owners fronting the impacted water body, users of that water body and the general public of the County;

4. Other reasonable, practical, and implementable environmental concerns of regional, state, and federal governmental agencies and professional bodies.

St. Johns County Tidal Wetland Management Alternatives

The maintenance of water quality conditions suitable for finfish and shellfish within the Moultrie Creek/Matanzas River/St. Augustine Harbor estuary will require coordinated management efforts between St. Johns County and the municipalities of St. Augustine and St. Augustine Beach. Actions to alleviate existing and projected problems by any single governmental entity in the area would have limited effectiveness. Effective protection of the estuarine environment will require common and consistent procedures adopted by all of the governmental bodies regarding stormwater runoff and waste management.

The problems identified in this report regarding the tidal portions of the Moultrie Creek watershed also apply to every watershed that discharges stormwater runoff and waste effluents into the Matanzas and Tolomota River systems. Stormwater management practices by the County and without cooperation from St. Augustine and St. Augustine Beach can only provide partial protection for the greater St. Augustine Harbor estuary.

An effective estuary resource management program would require participation from the three local governments whose practices determine the environmental health of the total St. Augustine estuary. Coordination of stormwater management practices among the three governments at policy levels and at governmental operational levels would be a major focus of such a program. Parallel functions in each governmental body impacting upon environmental conditions within the estuary would be identified. Information on problems and potential solutions to specific problems would be exchanged among the three governments. Technical assistance procedures among the three governments would be established, and coordinated means for dealing with emergency situations that impact upon the estuary conditions would be developed. Intergovernmentally coordinated procedures for obtaining state and federal assistance to resolve St. Augustine metropolitan area problems associated with the estuary will gradually evolve from the process.

Fresh Water Wetlands

Basic Processes

Wetlands exist in upland depressions, along flood plains of streams, and along the edges of base receiving water areas (upland depressions, lakes, and ponds). All wetlands have one primary characteristic. All wetlands are receiving or transition locations of runoff of surface waters and seepage of ground waters. They function as nutrient sinks or temporary storage areas for surface water runoff. In that capacity, all wetlands function to delay the movement of water. The time delay of water movement through wetlands allows biological and chemical actions to reduce detrital materials and provides time for the chemical bonding of conservative materials to sediment fines in the wetland. The sediment fines are introduced into the wetland through runoff or are created within the wetland through biological or chemical detrital reduction actions.

As water moves through and out of wetlands, minerals and nutrients are introduced from the wetland into adjacent water bodies. Under low or controlled water flow conditions, the transported minerals and nutrients from wetlands provide essential materials for sustenance of biological processes in adjacent water areas. Under high water runoff conditions through wetlands, large amounts of detrital materials and sediment fines with chemically bound contaminants can be washed out of the wetlands and into the adjacent waters.

Factors Affecting Upland Wetland Function Declines

Wetlands can persist only when they are able to receive regular and controlled amounts of surface water runoff and ground water seepage from the adjacent upland watershed supplying the depressional area. Once drainage programs alter the natural movement of water from the adjacent uplands or drain water to other locations, the original wetland begins a slow process of change.

Forested wetlands or swamps, bayheads, and hydric hammocks are primary sources of cypress and a variety of hardwoods used for commerce in Florida. As the uplands that formerly supplied the surface water runoff and ground water that seeped into these areas are converted to agricultural and urban land uses and the natural movement of water is altered, these areas also begin a gradual conversion to mixed mesic woodland or pine flatwood communities.

Without the regular supply of water from adjacent higher land areas, upland wetlands and their associated vegetation will gradually convert to areas with different soil characteristics and with different vegetation characteristics. The preservation of any upland wetland requires the hydrological determination of the regime of water flow or movement to the depression essential for sustaining a depressional area as a wetland with some desired vegetation characteristics.

In areas where the water table has been lowered through water withdrawals and overdrainage of surface waters, temporary sustenance of wetlands occurs due to the compacted bottoms of wet depressions that prevent or retard the infiltration and percolation of surface water. In these areas of perched water tables, the perched condition will persist for some time. As the available water declines, vegetation roots will penetrate the impervious clay layers in their search for water. Gradually, through the culmination of life cycles of this vegetation, progressive generations of this process, and subsequent root reconversion to natural elements, percolation through the clay bottom slowly increases.

Much of Florida was formerly in wet meadow vegetation. Prairies, meadows, or grassy wetlands all over Florida have been converted to agricultural and urban uses. High water tables due to lack of drainage prevailed wherever extensive flatland areas existed. Soils in these areas were soggy through much of the year, and progressive generations of grasses had produced accumulations of organic materials in the upper horizons of the soils. As the detritus broke down and released nutrients and sediment fines, percolation carried these materials to the water table and formed impervious layers. These impervious layers helped to perpetuate the natural wet meadow conditions.

When these areas were drained, usually for agriculture, the hot Florida sun caused oxidation of the organic materials that had collected on and in the surface soil materials. Agricultural practices broke up the upper soil matrix layers and the sun's actions caused further oxidation of organic fractions within the soils. As water tables were dropped and impervious soils layers were altered, water percolated downward and away from the soil surface.

When water tables are dropped more than roughly two feet below the land surface, the ability of grasses to obtain sufficient water without irrigation results in their reduced productivity. As vegetation functions decline, evapotranspiration also declines, and stormwater runoff has to increase. To compensate, agriculturalists have constructed larger and more efficient drainage systems. Similar practices have been followed by urban developers. The final result is the inability of the land to hold enough water to provide essential natural resource functions. In many parts of Florida where the surface soils have been drained, the water holding capacity of the sandy surface soils and the essential high water table conditions needed to sustain former wetlands no longer exists.

Long-Term Effects of Overdrainage

The following is an extreme example of the difficulty of attempting to rehabilitate wetlands following urban development and agricultural overdrainage practices. The water table aquifers along the Orlando Ridge, the Lake Wales Ridge, and the Osceola Plain in Central Florida formerly provided ground water seepage flows to sustain extended flood plain marshes along the Kissimmee River. The water levels in the Floridan aquifer along the Orlando Ridge at the head of the Kissimmee River have dropped largely through agricultural and urban development actions on the order of 35 feet over the last fifty years. Formerly high water tables and near saturated surface soils existed from Orlando southward on uplands of the basin through the 1960's. The formerly soggy surface soils typical of the basin's upland areas now are dry sands.

The formerly high water tables on the uplands surrounding the Kissimmee River flood plain will have to be recreated to provide ground water that can move as gravity flow and gradually seep onto the river flood plains. This cannot occur today because the potentiometric elevation of the Floridan aquifer throughout the area is very low, and infiltrating rain water percolates by gravity downward to the lower potentiometric levels of the Floridan aquifer. To redirect the movement of water table aquifer waters horizontally to the Kissimmee River flood plain will require the entrapment of enough rain water to recharge the Floridan aquifer to something near former potentiometric levels.

Assume, as an example of the difficulty of restabilizing former floodplain conditions, the Floridan aquifer can store an average of 3 inches of water per foot of elevation, and 3 inches of annual rainfall could be trapped and allowed to infiltrate into the aquifer on all of the upland areas around the Kissimmee River. Under this condition, it would take at least 35 years, assuming no incidents of prolonged droughts were to occur, to reestablish the ground water seepage flows necessary to sustain the former wetland flood plains of the Kissimmee River. The Orlando area, Lake Wales ridge area, and Osceola County are developing rapidly, and water demands are increasing commensurately. The technical likelihood of reestablishing the Kissimmee River flood plain wetlands is not promising. The above example is an extreme simplification of the overall regional problem of the Kissimmee River watershed. Solution of the Kissimmee River ground water recharge part of the watershed problem would require the coordinated efforts of Orange, Osceola, Polk, Highlands, and Okeechobee counties and numerous municipal governments.

St. Johns County Upland Natural Resource Concerns

The St. Augustine metropolitan area partially depends upon the surficial aquifer beneath the Tillman Ridge for public water supplies. On a average, every 1,000 new people will require at least 100,000 gallons of water per day or 35 million gallons of water per year. The existing withdrawals are already resulting in water drawdowns and less ground water seepage to Trestle Swamp and the headwaters area of the Moultrie Creek watershed. Unless rainfall water storage practices are initiated in St. Johns County, neither the surficial aquifer water supplies nor the existing Trestle Swamp wetlands can be preserved. It is far simpler and more cost effective to begin the process of protecting the County's water resources for various purposes early in the area growth process than to attempt to restore the resource at some later date.

The Cowan Swamp at the head of the Moultrie Creek channel is also in jeopardy. Old gridiron plats and scattered residential development now exist within the depression storage area of Cowan Swamp. Ditching and draining is now occurring. As more people purchase properties in this area they will demand drainage improvements. Because the County permitted this type of development, the County is now obligated to provide for a healthy living environment for these residents. The preservation of the wetlands environment in Cowan Swamp is essential for continued base flow in Moultrie Creek and for the sustenance of the environment in the tidal estuary part of Moultrie Creek. The incompatibility of past governmental actions, the health of the area's environment, and the public health needs of residents will require remedial governmental actions that will be costly to County taxpayers. The County need only look at the multi-million dollar drainage programs now being demanded by Jacksonville residents to see the future of the existing conditions in the Cowan Swamp area.

The difficulty of preserving the Cowan Swamp is further compounded by the extensive uncontrolled positive drainage occurring to the east of Moultrie Creek. The water table reduction required for the coquina mining operations can be expected to gradually result in a long-term decline in the water table beneath Cowan Swamp and much of the land area south of State Road 16. As the dewatering of the area continues, Moultrie Creek can be expected to experience more days of zero flow and longer extended periods of zero flow. The dewatering effect on the general area also can be expected to gradually affect water levels in Five Mile Swamp and Four Mile Swamp.

Finally, as the demand for potable water from the surficial aquifer increases, and positive uncontrolled drainage continues, the inevitable declines in water table conditions can be expected to result in the following:

1. Increasing residential demands for lawn watering to support landscape vegetation;

2. Progressive salt water intrusion into surficial aquifer areas adjacent to Moultrie Creek and the Matanzas River;

3. Progressive incidents of upwelling saline water from the Floridan aquifer as the weight of the fresh water in the surficial aquifer is removed;

4. Progressive deterioration of wetland conditions in the tidal parts of Moultrie Creek as fresh water discharges change from the former steady base flow rates to pulses of heavy runoff following rainfalls;

5. Increasing loads of sediments carried into the tidal part of Moultrie Creek along with increasing runoff from rainfall;

6. A gradual extension of the deteriorated estuarine conditions from Moultrie Creek throughout the greater St. Augustine Harbor estuary.

Federal Fresh Water Wetland Permits

The U. S. Army Corps of Engineers regulatory program considers as waters of the United States all tributary streams to navigable waters to a point where flows are less than five cubic feet per second. In general, this criterion is being interpreted as the uppermost five square miles of all watersheds, but actual determination is made on a case-by-case basis. The determination of federal jurisdiction of a proposed project will be made by the Corps of Engineers. All proposed development actions by private individuals or public agencies are subject to Corps of Engineers regulatory review.

Florida Department of Environmental Regulation Permits

Previously cited Florida Department of Environmental Regulation evaluation criteria for tidal wetlands also are applicable to fresh water wetlands.

St. Johns River Water Management District Criteria

The St. Johns River Water Management District (SJRWMD) considers wetlands as hydrologically sensitive areas and conduct regulatory review of proposed developments in these areas in accordance with Section 373.016, Florida Statutes (Section 40C-4.021(5), Florida Administrative Code). Information on the St. Johns River Water Management District's wetland regulatory procedures may be obtained from: Office of Rules and Policy Development, St. Johns River Water Management District, P. O. Box 1429, Palatka, Florida 32078-12429.

WETLANDS REGULATION PROBLEMS

The enforcement powers of the federal and state government are being applied to all proposed development actions that directly disturb tidal and fresh water wetlands. Governmental actions to evaluate the effects of upland areas development that can functionally deprive existing wetlands of the surface and ground water essential for their maintenance is normally given limited consideration.

Primary governmental efforts directly focus upon existing wetland conditions and areas. Field inspections typically give limited review to the long-term functional condition of observed hydric soils, the vegetation indications of an expanding or contracting wetland condition, and the hydrological regime necessary for sustaining wetland conditions for a given depressional area of some determined size.

The differing jurisdictional reviews of upland wetlands are based upon different criteria used by the reviewing agencies. Private property owners still do not have clear non-conflicting criteria to follow that may be acceptable to all permitting agencies.

Field interpretation procedures used by the differing regulatory agencies are not consistently determined among differing field inspection personnel in any of the regulatory agencies. The three primary field inspection criteria (hydric soils, indicator vegetation, and actual hydrological conditions) require cross training and significant field experience before consistency in judgmental decisions is achievable.

Finally, the emphasis given by all regulatory agencies is focused upon the ability of the agency's enforcement power to regulate. The desire to provide practical and useful guidance to improve the proposed development action in a manner that could achieve the practical purposes of environmental management in an expanding urban environment is generally lacking. As a result, advocacy, confrontational, and avoidance positions are often resorted to by private property owners.

A FUNCTIONAL BASIS FOR NATURAL RESOURCE AREA MANAGEMENT

Natural resource areas have functional utility beneficial to the well being of St. Johns County residents. These areas perform a number of functions that enhance the County's natural environment. These functions include:

1. Retarding stormwater runoff by serving as temporary water storage areas;

2. Serving as drainageways and flow-ways that relieve flooding in urban areas while also slowing stormwater runoff;

3. Serving as sediment and nutrient sinks where materials are slowly reduced and nutrient and mineral components essential for other biological processes are slowly released to streams and estuaries;

4. Serving as wildlife retreats or protected areas in uplands and as nursery and feeding areas for wildlife, fin fish, and shellfish in estuaries;

5. Serving as protected corridors for migrating wildlife;

6. Providing commercially useful wood and other vegetation based materials;

7. Functioning as natural green space areas within developments separating urban land use functions;

8. Functioning as a resource for local nature study of climax and transitional natural vegetation;

As St. Johns County continues to evolve from a predominately rural to a highly urbanized County, the need to protect existing natural resources and support the creation of new natural resource areas will become increasingly apparent. A balance between subdivisions and natural areas is highly desired by Florida residents. A County management program to encourage the protection and enhancement of existing natural areas and the construction of new wetlands and woodlands as stormwater storage and drainageways would serve many County resident's desires.

Management practices are needed that serve to encourage private property owners to incorporate new natural resource management concepts into their projects. The present emphasis upon protection of wetlands by governmental powers at state and federal levels without commensurate emphasis upon assistance to property owners to provide functionally effective natural areas achieves little more than submission without empathy. The continued loss of essential natural resource areas can be expected from the existing governmental divisiveness in wetlands regulation.

A County program that provides clear development criteria can be established to meet the stated intents of all state and federal wetlands legislation. Such a County program will include improved policy level and technical level coordination with regional and state development review agencies. As the County program evolves, the need for intensive state and federal review will become more perfunctory.

CREATING NATURAL RESOURCE AREAS

Retention Storage Areas

Retention storage requirements to accommodate the first one inch of all rainfalls can be constructed in a wide variety of forms depending upon the natural storage capacity of local soils. The basic storage capacity of soils can be determined from available Soil Conservation Service runoff curve number information. All types of minor depressions can be created at elevations above local area annual high water table conditions. Swales, or elongated depressions without outlets or with controlled overflow outlets, are the most common type of retention facility now in use in Florida, but all slightly lower land areas between raised residence pads and raised roadways can be used. On essentially flat lands with normally high water tables, raising residential house pads and roadways by two or more feet can effectively provide the necessary detention/retention storage while preventing flooding of structures and flooding related transportation hazards.

Created sloping topography with low berms along contours can serve to retain low intensity rainfalls. On slightly sloping land, flat benches also can be created along contours to retard the sheet flow runoff. The extensive use of broad, low elevation recontouring of subdivision, commercial, and industrial open space areas can provide the required retention storage requirement while effectively reducing sediment transport potentials. Where extensive reworking of the land surface occurs during the project construction phase, the construction of sediment basins may become necessary until a new vegetation cover is established. Care in the design of the construction sediment basins permit their continued use as a permanent detention/retention areas.

Retention areas should be designed with overflow locations capable of passing the very infrequent and heavier rainfalls. Overflow should be directed into detention storage basins, drainageways, flow-ways, or controlled flow discharge channels.

Detention Storage Areas

Detention storage areas are intended as temporary storage areas built to accommodate water depths from heavier rainfalls that must be stored for a short time within a development while discharge channels release stormwater at a controlled rate. Any land area capable of holding water without causing flooding of structures and roadways can serve as detention storage areas. These areas may be extensions of retention areas where the first one inch from a subwatershed area is not released, but water runoff accumulations to depths in excess of the one inch retention requirement are released through saddles or limited capacity drain pipes to the major storm sewer or surface drainage system. Playgrounds, general recreation areas, golf courses, woodlands, created wetlands, etc., can serve as detention storage locations. Where shallow drainage channels are constructed, tieback areas from the discharge location weir, flume, dropbox, etc., can be raised sufficiently and extended as low levees or broad berms connected to higher ground to form an extended detention storage area.

Drainageways and Flow-ways

Constructed drainageways are intended as very low profile slope systems extending across broad areas that allow stormwater to flow slowly. Natural systems may be wooded or wet meadows. When constructed within the annual elevation range of a local water table, the drainageway will evolve into a natural wetland typical of a slough. A natural slough may have a width of several hundred feet, very gradual side slopes, and maximum cross sectional depths of three or four feet. Created drainageways will be similarly constructed.

Within developments, black willow and cattails tend to become the first opportunistic vegetation to occupy these areas. A wide variety of other vegetation natural to north Florida can be planted to accelerate the establishment of natural woodland or meadowland conditions. As the vegetation becomes established, the hydraulic roughness of the drainageway will increase. The design of the system will be based upon the flow roughness expected from the mature system. Again, by weiring or other means these areas can be designed to provide some detention storage from the infrequent periods of heavy rainfall.

Flow-ways are vegetated areas designed to accommodate the overflow from drainageways and carry runoff from heavy rainfalls around drainageways or water storage facilities. As with drainageways, flow-ways will restrict discharges to a rate of 1.5 cubic feet per second to prevent sediment transport and land erosion. Flow-way design permitting a short term 2.3 cubic feet per second discharge velocity for runoff equivalent to the amount expected from the five year, one hour rainfall occurring on saturated soils will be accepted. This higher discharge velocity will be used to estimate potential runoff expected only as peak discharge from those infrequent 24 hour storms expected on a return frequency basis of 25 years and less frequent storms with still greater rainfall depths. Routine distribution of runoff from the 25 year, 24 hour, rainfall anticipates a short period of more intense rainfall.

Flow-ways associated with drainageways have bottom elevations at or slightly above the normal high water table elevation for the local area. A constructed flow-way can be flat bottomed or slope slightly away from the drainageway towards higher ground. The profile slope of the flow-way will parallel the similar slope of the drainageway. The width of the flow-way will be determined by hydrological analysis to, as a minimum, carry the remainder of the 25 year, 24 hour, runoff from the local watershed that is beyond the carrying capacity of the drainageway.

Flow-ways may be designed as a separate major stormwater runoff collectors of a total system. These facilities will have bottom elevations above normal high water table conditions for a local area and will remain dry except during periods of heavy rainfall. A flow-way will be constructed with broad and shallow cross sections and with gradual sloping sides on the order of 1:4 (one foot rise per four feet horizontal) or less. Any considered use of steeper side slopes will require periodic placement of egress means to permit safe exit by children and animals.

If vegetated side slopes and flow-way bottoms are to be part of the design, the bottom will be sufficiently broad to permit vehicular access within the flow-way for maintenance. Vegetation within the flow-way system will be limited to grasses and sedges.

Broad flow-ways also will be designed with maintenance accessways on each side of the flow-way. Open woodland vegetation planted outside of grassed accessways on either side of a flow-way would improve the aesthetic acceptability of system within urban areas. The integration of the flow-way system with other open space functions such nature trails or walkways and parks is encouraged.

All storm sewer feeders lines and secondary surface drains providing runoff to the flow-way will have controlled flow outlets and sufficient armoring of tailwater areas to assure that discharge water velocities will not erode the flow-way's bottom or sidewalls. Where trails and walkways are designed as part of the system, outlet structures can be modified for use as pedestrian bridges or viewing locations.

Outlet localities of flow-ways will be at locations where flow velocities must be increased due to designed system changes of profile slope. These locations will be armored to prevent erosion. A wide variety of system designs can be used. Gunnited or simulated rock garden spillway and water velocity absorbing areas can be constructed and incorporated into a development's landscaping plan. Where such efforts are undertaken, hydraulic design to accommodate the 50 year or 100 year stormwater runoff conditions will assure a longer life for the outlet locality of the flow-way.

Ponds and Lakes

Constructed ponds and lakes have long been used in Florida to augment subdivisions. Most are actually borrow areas from which fill has been obtained to provide a desirable contoured landscape for the development. The use of ponds and lakes in new developments is an attractive amenity when properly constructed. Grassed side slopes should be at least 1:4 (one foot vertical to 4 feet horizontal), for resident safety and erosion prevention. Gradual slopes should extend into the pond or lake for a distance of at least 10 feet from the normal water elevation shoreline. The area above the normal high water table elevation of ponds and lakes can be used for water detention storage.

Where constructed in close proximity to residential units, the need for lakes and ponds to be able to accept runoff from heavy rainfalls may preclude their consideration as retention/detention storage facilities. Lakes and ponds constructed as an urban area amenity must retain water. Many such facilities have impervious bottoms to retain surface waters, and, therefore, have limited retention potential. Capacity, outlet facility capability, and discharge channel capability calculations will have to demonstrate the ability of these facilities to function effectively for both purposes.

Borrow Pits

Borrow pits are considered as material extraction areas with no further end use anticipated. The need for sand and coquina extraction for various development purposes in St. Johns County is expected to expand with urban development and the construction of new roadways. A finish design that will reduce the hazard potential of these areas is necessary. Borrow pits normally are deep excavations with steep side slopes. Because the excavation extends below the normal water table, borrow pits fill with ground water seepage.

To reduce the hazard potential to humans and livestock, these areas will be constructed with a minimum 10 foot wide access roadway at normal ground elevation around the entire perimeter of the pit. Outside of this accessway, a swale type parallel depression at least 15 feet wide and extending to a depth of at least three feet will be constructed around the pit. One 10 foot wide entranceway will permit access to the edge of the pit. Upon completion of use, the entranceway will be blocked by fencing or other means.

The above criteria will provide a created depression surrounding the borrow pit that will evolve into an wetland populated with opportunistic vegetation. Any sheet flow moving towards the excavated area will first pass through the created wetland environment. Similarly, any overflow from the excavated area will again first pass through the created wetland depression. The system normally will not have an overflow outlet, but a constructed drainageway to a nearby natural drainage system will be permitted.

Greenbelt Woodlands

Larger developments have the opportunity to preserve or create extended greenbelt woodlands. These areas may be transitional zones extending from wetlands. They may be created extensions of existing upland woodlands. Greenbelt woodlands perform the a variety of functions in urbanizing areas. As extensions to drainageways, they provide protected corridors for the migration of wildlife. In an urban environment, woodlands serve as recreation areas for observing wildlife and other nature related experiences. Woodlands serve as visual natural area breaks between urbanized areas. Such areas also serve to alter wind flow patterns.

Even small developments can improve the amenity value of properties by preserving patches of natural woodland. These areas can be extended by lineal plantings of native vegetation within and adjacent to drainage easements and constructed flow-ways.

Created woodlands can be planted with a variety of trees native to north Florida that provide food for desired wildlife. Along the fringes of created woodlands, a variety of food bearing vines and grasses also can be planted to support desired wildlife. North Florida has a rich variety of natural vegetation that provide sources of food and shelter for wildlife and are adaptable to urban environments. Guidelines for use by property owners for this purpose can be prepared and distributed by the County within the context of its development management program. These guidelines could be developed as extensions to the St. Johns County Landscape (Green Law) Ordinance No. 79–19.

MANAGEMENT CONCEPTS

Data and Information Needs

Large land areas of St. Johns County are undergoing conversion from open space and agriculture to urban uses. The current conversion is expected to continue through the foreseeable future. More effective methods are needed for evaluating the impacts of proposed developments. Improved methods for evaluating potential impacts of development are needed before land parcels are committed for development if essential County resources and existing natural areas are to be protected.

This report has identified the need to review proposed development actions with recognition of potential long–term impacts upon natural resource conditions in the County important to the majority of residents. A first step has been taken to begin the process of developing basic and objective information on conditions within the Moultrie Creek watershed. This information is now being incorporated into a computer geographical information system. This system and its associated database will permit spatial analyses that will more clearly pinpoint potential problems within watersheds. With this information, means for alleviating existing urban area problems and avoiding future problems associated with proposed development actions can be more clearly identified. The continued extension of the process started in the Moultrie Creek watershed provides the most cost-effective means for avoiding future problems associated with expected urban development within the County.

The County could benefit from revisions in the development permit application process that provide for permit application information to be routinely entered into the geographic information system and other departmental databases. Much of the information presently prepared is procedural in nature and is readily adaptable to entry and recall as computer procedures are expanded.

As the County moves to greater dependence upon computer systems, procedures can be modified to reduce the departmental work loads related to the permit application review process. Changes in the review process also would benefit applicants as procedures are clarified and simplified for data entry and recovery purposes.

Additionally, most property owners are unaware of the details of the County's need to permit economic development while, at the same time, providing for the health and welfare of all citizens. It is incumbent upon the County to provide clear information on the purposes of essential restrictions, as well as the dictates of those restrictions.

The process of revising development related ordinances and preparing public information on the purposes and essential conditions of such ordinances will require substantial inter-agency coordination within the County government. This is an internal governmental process that can be expected to require a significant and long-term effort.

Natural Resource Diversity Needs

A need also exists to maintain a diversity of natural resource areas within the County. This can be accomplished through the protection of existing areas, where practical, and the creation of new areas to perform essential functions of natural resource areas as integral parts of new developments within the County. The following outline lists the steps required to establish County-level management procedures for protecting and enhancing significant natural resource areas.

1. Define the conditions that identify significant natural resources.

2. Identify subtypes of each category of area that would require different governmental review and action procedures.

3. Develop technically supportable, and legally binding procedures for delineating these areas.

4. Provide clear statements of the significance of each area.

5. Develop internal review procedures for proposed development actions.

6. Develop database and geographic information system analysis procedures for evaluating development actions and for maintaining records of the character of each area, its condition, and requirements for maintenance.

7. Prepare urban and agricultural development compatibility guidance to assist adjacent and nearby property owners to undertake property improvements that will not detract from, and may improve, adjacent significant natural resource areas.

8. Prepare performance standards applicable to future adjacent and nearby property improvements.

9. Prepare a clear and simplified application and a one-stop development approval process to be followed by property owners.

10. Provide, as available and where applicable, technical guidance, assistance, and support to property owners when parallel development approvals must be obtained from regional, state, and federal offices.

11. Develop and consistently implement, reasonable, legally unambiguous, and cost effective enforcement mechanisms applicable and applied evenly to all proposed development actions to assure that the County's

natural resources and conditions that protect the public health and welfare are preserved or enhanced by each proposed development action.

General and Public Information Needs

Additional general information on the area's resource management problems is needed. Information that would permit governmental operations personnel to recognize the need for changes in operations practices would be highly beneficial. Information that would permit policy-level bodies to respond to, and apply, the most cost-effective measures for the benefit of all residents also should be prepared. Finally, property owners who wish to invest in the area should be able to obtain clear guidance on County management purposes, as well as the letter, of development restrictions.

The general public also needs improved information on the meaning of regional water management and how changes in policies and practices will affect their lives and the cost of living within the area. The process of regional water management will require improved educational information for use in County schools. Information is needed on real problems in St. Johns County and how individuals make a difference in solving problems and in creating a more desirable living environment for everyone. The above actions provide a means for developing the support and the consent from St. Johns County residents for improved County resource management practices.

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WATER MANAGEMENT PROGRAM

BASIC PROBLEMS

This study has identified a broad range of water related problems that are interrelated. The general public has a very limited perspective of County water management needs. General County government concepts focus primarily upon the need to drain areas and prevent flooding. The public tends to become concerned with a government's water management program for short periods following rare and extremely heavy rainfalls or storms that cause catastrophic conditions. Many years may elapse between natural events that cause serious problems. The governmental related problems resulting from each event are remembered by too few people.

As St. Johns County continues to develop, the individuals who witnessed previous heavy rainfalls, flooding events, and the host of problems associated with such natural occurrences will become smaller proportions of the County's total population. The newer population will be unaware of potential water related problems and will be less tolerant of resulting conditions.

For example, earlier residents of Florida living in a more relaxed environment were much more tolerant of street flooding than current populations. St. Johns County is rapidly becoming a residential County for people working in the greater Jacksonville metropolitan area. These newer residents will be less tolerant of periodically flooded streets that hinder daily activities or make living conditions more hazardous.

All residents are concerned about the increasing cost of governmental functions. The water management program outlined in this report will result in some increased governmental implementation costs. Either the increased costs are levied against new developments by initially requiring the use of higher levels of technology, or the costs are transferred to the general population at a later time through higher levels of governmental facility repair and future remedial actions.

Sound engineering practices exist to prevent or reduce water related infrastructural problems and natural resource deterioration. The following information is provided as suggested guidance for a County-wide water management program. The information is intended only for use as a base for internal discussions within St. Johns County during the development of a scope and structure of a program acceptable within the County.

ST. JOHNS COUNTY WATER MANAGEMENT PURPOSES

Basic Concepts

1. St. Johns County is a highly desirable place to live, but experience shows that haphazard development can be detrimental to the interests and concerns of the majority of the area's residents.

2. Development will continue to occur throughout the County and it must be accommodated.

3. The County can absorb all prospective growth without resorting to progressive destruction of the region's water and other natural resources.

4. County water and other development management actions can provide for sound economic growth while continually improving the living amenities of the area.

5. Careful review of proposed development actions and pre-development resolution of potential problems are more cost effective actions benefiting the majority of St. Johns County residents than future remedial actions that may become necessary to correct development related problems.

6. County governmental review of proposed developments must focus upon the potential long-range costs to County residents of a proposed development and the manner in which a proposed development will impact upon area environmental amenities and the social and economic well being of the majority of County residents.

7. Private property owners and developers must recognize that the potential profitability of a proposed development action is a private concern to be evaluated within the framework of County development constraints considered by the majority of residents as essential for

the maintenance of their health, social and economic well being, and the area's natural resources.

8. The majority of individual property owners, developers, and associated legal and technical representatives do care about the local area and are willing to ensure the long-term contribution of their development to the area's well being through careful actions and adherence to County water and natural resource management concerns.

9. The County government is obligated to develop and maintain a comprehensive understanding of the social and economic concerns of residents, general growth management needs, and criteria essential for designing and developing projects that will not damage and can improve the infrastructure, water, and other natural resources within basins or other regions in the County.

10. The County government is further obligated to provide essential guidance and assistance to individual residents and property owners to assure that proposed development actions are undertaken within the framework of County water and natural resource management goals, objectives, and development constraints.

11. Strong and effectively implemented County pre-project, construction period, and post-project enforcement measures are necessary and essential to protect the County's resources, the public health, and the social and economic well being of majority of the County residents.

Moultrie Creek Watershed

Concepts

1. The water supply and environmental resources of the entire St. Augustine metropolitan area are affected by County water management decisions made regarding proposed developments in the Moultrie Creek watershed.

2. The region's economic growth potential, individual's costs of living, and the St. Augustine metropolitan area's social, economic, and environmental amenities will be detrimentally affected by continuation of haphazard development and uncoordinated proposed development review procedures in the Moultrie Creek watershed.

3. Basic information being prepared for the Moultrie Creek watershed is still incomplete, but newly assembled materials identify problems sufficiently to provide direction for County actions needed to further improve the County's ability to provide for the health and social and economic well being of Moultrie Creek watershed residents.

4. Coordinated development review procedures will be required among County government agencies with responsibilities for protecting the public health, social and economic well being of residents, and the County's infrastructural base (roads, drainage, and utilities).

5. Coordinated programs, with direct and continual participation among all local governments, will be required to assure the adequacy in quality and quantity of the regional water supplies and the protection of the region's environmental attributes.

6. An expanded program is needed immediately within the County Engineering Department to prepare and distribute improved development related guidance for use by individual property owners and large land developers based upon sound and current engineering principles that reflect the total water management needs of the County within the Moultrie Creek watershed.

Subbasin Stormwater Management

Engineering Department capabilities currently are being fully utilized for permit application reviews, pre-application site inspections, and emergency field inspections. Further formalization of these current activities to provide information suitable for identifying subbasin locations of inspected sites can provide much of the required database information necessary for subbasin analyses. As capabilities within the Engineering Department increase and fuller data are entered into the geographical information system, further development of information on existing stormwater management systems essential for subbasin evaluations can be assembled.

Subbasin stormwater management procedures consist of analyses of existing systems in platted areas to determine operational functions and improvement needs. The analyses provide a means for the Engineering Department to determine potential effects of new developments which propose to connect to older conveyance systems. This process will be applied to all problem areas where new subdivisions have been constructed in recent years and still additional new development is proposed within a subbasin. The process is specifically needed to establish the potential, long-term impacts of continued and total development upon natural stream courses and final receiving water bodies.

Eventually, the County will have to undertake the rehabilitation of older systems within some platted areas. Master plan preparation and the construction of systems within existing platted areas also will have to be undertaken by the County. Subbasin analyses of these areas by the Engineering Department will provide necessary information on the rehabilitation needs of older drainage systems accepted by the County.

The following information outlines stormwater management analysis procedures useful for subbasin level evaluations of potential impacts from new development and for remedial stormwater system rehabilitation and reconstruction. Primary evaluation considerations for the above purposes would include the following:

1. Segmentation of watersheds and delineation of subbasin hydrological units or areas with similar types of water conveyance. Wetland preservation analyses would require such delineations to include the probable ground water contribution areas and surface water drainage area supplying water for the wetland's sustenance.

2. Field inspection of all conveyance units (natural streams and drainageways, channels, and structures) to establish existing conditions and need for improvement of each unit identified. The condition and capacity of each conveyance segment and each structure must be established. This process requires a standardized evaluation process based upon previously accepted engineering criteria. The conveyance capabilities of natural and constructed segments must be determined. The field inspection process also will identify those natural systems that can be improved and those systems that must be preserved in existing conditions.

3. Subbasin hydrology will establish expected runoff conditions, retention storage requirements, and the hydraulic adequacy of the existing natural and constructed conveyance systems. For new subdivisions, the developer is required to prepare a hydrological analysis. Once the County accepts plats and constructed drainage systems, maintenance and rehabilita-

tion normally become County or homeowner association responsibilities.

4. The hydraulic analysis of existing conveyances will include identification of utilities, roadway segments, private ingress points to roadways, and other factors that are affecting the overall system's performance. A rating system for determining the significance of each constraining factor will be developed as a basis for determining necessary improvement and for scheduling such improvements.

5. The above rating system will include means for evaluating impacts upon natural areas and constructed conveyance system components. Included in the rating system will be an estimate of direct costs for improvements and cost estimates for subsequent improvements required at downstream locations.

6. The above information will provide estimates of costs to the County resulting from continued development within subbasins. This information will permit the County to establish potential impacts on existing systems resulting from new subdivisions. The information also provides a basis for determining County costs for improving stormwater management systems in older platted areas.

7. Once basic subbasin hydrological and hydraulic data have been developed, the probable effectiveness of detention and retention storage procedures can be assessed more completely. These assessments are particularly important for maintaining significant natural resource areas. In upland areas, the assessments will establish the water regime provided to wetlands. In tidal areas, the concern is oriented towards a reduction of strong pulses of stormwater immediately following rainfalls and the need to increase in base flow from ground water seepage.

8. A program to address the ongoing and existing problems in watersheds and subbasins of each watershed provides the basis for watershed stormwater management. The effort requires the development of hydrological and hydraulic data, evaluation of existing conditions, determination of impacts from new developments, estimates of costs for necessary improvements undertaken by the County, and a schedule for undertaking the required improvements.

The above process will require the County Engineering Department to allocate some part of its routine operations to the identification of primary stormwater management problem areas within the County. Field inspections have already been conducted to determine the conditions of major structures in the Moultrie Creek watershed. The conveyance unit condition and capacity determinations remain to be undertaken. These data are being placed in the geographical information system database as non-priority entry items.

The Engineering Department has the technical capabilities for undertaking the subbasin analysis process, and necessary analyses can be undertaken as sufficient staff engineers and engineering technicians are trained to conduct other review and inspection functions. Subbasin analyses and master plan type system rehabilitation analyses are normally undertaken by internal staffs of large municipalities and counties.

Effective stormwater management coupled with broader water management needs of St. Johns County require the development of an active program for subbasin analyses within the Engineering Department. Computer technology for undertaking necessary evaluations are now readily available and inexpensive. Microcomputers sufficient for these analyses are being used within the Engineering Department. The geographical information system database information is being assembled. A program for the gradual development of the subbasin analysis process can be accomplished as departmental staffing needs are met.

COUNTY ENGINEERING DEPARTMENT FUNCTIONS

Program Development Efforts

The St. Johns County Commission recognizes the need for an improved operational program within the County Engineering Department. Changing long standing practices is a complex and difficult process. Sound engineering decisions require a staff of trained professionals. Modern water management practices in Florida require that professional engineers and technicians in the County Engineering Department have competent backgrounds in current techniques for evaluating existing and potential effects of ground water and surface water. The County Engineering Department must be able to provide current technology guidance to County officials and the public on: (1) flood potentials, (2) reducing flood hazards,(3) protecting ground water resources, (4) providing water control measures to protect and enhance significant natural resources within the County, (5) assuring that private water control measures do not pose a future hazard that may result in damages to public and private properties or harm to residents, (6) and assuring that sound, up-to-date engineering principles are used in the construction and maintenance of the County's very high cost infrastructure (roads, drainage systems, and utilities).

Over the past several years, the County Commission has provided for the gradual transition of the County Engineering Department operations to provide for the ongoing and future growth within the County. As part of this transition process, the study of the Matanzas River - Moses/Moultrie Creek watersheds was initiated to identify water related development problems and a means for resolving existing and preventing future water management problems within these watersheds. This initial study effort was oriented towards the assembly of base level information needed for water management purposes.

The second phase of the study effort has focused on the Moultrie Creek watershed. A concentrated effort has been underway to finalize the assembly of basic technical information on the watershed, while, at the same time, preliminary departmental procedures for using the newly available information were identified and initiated. Part of this process has included improved inter-departmental coordination and immediate use of newly developed data and information. A final part of this study effort has been oriented towards the identification of changes needed in the Engineering Department's water management procedures and operations. While the focus of the study has been on the Moultrie Creek watershed, the watershed has served primarily as a model for improving the Engineering Department's response to development problems throughout the County.

Basic Data and Information Development

Purpose

The County Engineering Department has been faced with the problem of reviewing development requests while technical information needed to determine the regional water, other natural resource, and infrastructural effects of proposed development actions have been lacking. Under conditions of slow growth, small population centers, and primarily distributed rural land use patterns, pressures on County water related resources were limited. This condition has changed, and urban development pressures exist and are expanding throughout much of the County.

Without adequate data and information and a development review program applicable to, and evenly applied to, all proposed development projects, little potential exists to maintain or enhance the County's water and other natural resources. Failure to implement a fair and effective program applicable to all potential development actions will result in: (1) the continued deterioration of the County's natural resources, (2) the ultimate spread of the deteriorated urban blight conditions in those developments which do not provide suitable living conditions required by future residents, and (3) extremely high future costs to long term County taxpayers for remedies to solve problems created by permissive governmental actions. A number of very large scale developments are currently in planning stages in St. Johns County. Numerous other smaller satellite projects also are already underway or are being planned. The quality of future water and other natural resource conditions and the general quality and cost of living in St. Johns County will be heavily impacted by the combined effects of these current and planned development projects.

Geographical Information System

In recognition of the need to begin the process of developing improved base data, The County Commission authorized the purchase and development of a computer-based geographic information system. Initial development of this system also was supported by the Florida Department of Environmental Regulation as part of the Moultrie Creek watershed study.

A computer-based geographical information system permits the development, maintenance, and evaluation of data in more effective formats than were previously possible. The process requires the digital coding of specific types of data keyed to a location. Wide varieties of data can be entered and recalled for evaluation. Any combination of data can be recalled for a single location or locality for visual review. This aspect of the system is now in use by the Engineering Department for those locations and localities with data entered into the system.

Basic information being coded into the system includes Soil Survey Data, topographic data, natural drainage system data, property plat data, roadway data, water and sewer utilities data, constructed drainage facilities data, floodway and flood prone area data, and natural resource areas data. Zoning data remain to be entered into the system. Various types of socioeconomic and land use information being developed by consultants will be entered into the system as the data become available. Plans are underway to expand soil survey data to include more engineering criteria available for soils conditions and data on natural water table conditions. A wide variety of other specialized types of information are being considered for entry into the system by other County agencies. System expansion and networking procedures for these purposes are underway. Also being studied, are data exchange programs with regional, state, and federal agencies. A variety of data on St. Johns County are being collected and maintained on other database systems. Procedures and arrangements for obtaining data useful for County management purposes need to be developed.

As the above information is entered into the system, it is becoming practical for the County to provide property owners with improved data essential for designing projects and for meeting County development constraints. Much of the information being incorporated into the system was previously unavailable to property owners and small developers in understandable forms and at a reasonable cost. A program is planned to develop procedures to make basic information available at a reasonable cost and to permit controlled access to the system by technical professionals who are willing to obtain training in the use of the system.

A geographic information system represents a level of technology that requires care in development and operations. Personnel entering data into the system require training in the system operations and an understanding of the significance of the data being entered. Academic and commercial training programs for these purposes are not available, and on-the-job training in County Engineering Department operational requirements is needed and must be developed. Effective use of the system will be dependent upon the quality of the people employed by the County to operate and maintain the system.

A geographic information system is not viable as a purchased service. Engineering Department review personnel must be trained in data entry and access procedures to be able to perform their normal functions. Two levels of data entry are required. Initial digitizing or scanning can be accomplished by individuals with limited training. Some Engineering Department technical review personnel are already trained to undertake the first step of digitizing incoming data. A second step consists of editing the digitized information before final entry into the system.

Editing and finalizing data require a more complete understanding of the performance levels required by users of the system. Complete documentation procedures for training personnel and monitoring both levels of data entry need to be developed for each type of data being incorporated into the system. This process has been started but must be fully developed and applied to each new type of entered data.

The start-up of the system also identified the need for standardizing database system management. Initial data has been entered for the Moultrie Creek and Moses Creek watershed studies. As data for other parts of the County or for use by other County departments are entered into the system, standardized procedures for entering and accessing data for the entire County will have to be fully documented. As the information is assembled in standardized forms, it will become practical to array and display various types of information for any small or large geographical area in the County. Similarly, numerical data representing any desired area in the County will become easily accessible, and measurements of area-wide conditions or attributes at some location will become available for evaluating proposed developments.

Geographical information system management decisions will have to be made for every new system user within the St. Johns County government. Decisions will be needed to determine whether information suggested for incorporation into the system is critical or not essential information. Every type of data to be entered has a cost. Data must be developed, entered into the system, and stored as part of the system. Costs are associated with each of these functions. If desired data are not to be used widely or regularly, a decision will have to be made on whether the costs of assembly and entry are worthwhile.

As data are entered into the system, the database storage requirements for each attribute or overlay must be determined. If stored off the system, procedures must be developed for loading and unloading the data for some use. Management decisions to control access to the system also must be developed. Complete documentation of the geographical information management process and a priority schedule for system development within available County budget constraints also must be developed.

The development of the system management process is underway within the Engineering Department. A framework for the management process and a schedule for the long term development of critical database information for other areas within the County and other user departments within the County will be prepared during the current fiscal year.

Guidelines

The Engineering Department recognizes the need to provide improved guidance to individual property owners and large developers desiring to undertake developments within the County. This report provides outlined information on many of the water management related types of information that must be developed. Individual property owners and small developers do not have access to the full range of professional engineering services available to large developers. Additionally, many small engineering firms do not have ready access to adequate technical information for evaluating the inter-relationships of ground and surface water management. Similarly, it is difficult, confusing, and costly for individuals to be responsive to the varied environmental rules of local, regional, state, and federal enforcement agencies.

The Engineering Department has begun the process of developing fundamental information for use by private individuals requesting applications for developments. The initial guidelines will consist of hydrological and hydraulic analysis procedures that will be acceptable to the Department. Much of the information outlined in this report gradually will be expanded upon and restructured as guideline information to be provided for use by individuals interested in some form of development action. The Engineering Department will coordinate the guideline preparation efforts with other local and regional agencies in an effort to incorporate simpler and more consistent procedures for individuals to follow during a development action.

Technical Investigations

This study of the Moultrie Creek watershed identified problems and conditions which require further investigation. The study has raised questions concerning an apparent need to improve water recharge to the surficial aquifer lying beneath the watershed. Questions have been raised about current drainage practices and potential impacts upon significant natural resource areas. The need to develop clear means to delineate areas considered as significant natural resource areas also was noted. Concerns have been raised by the Department of Environmental Regulation about potential pollution of the greater St. Augustine estuary from roadway drainage and other urban activities. Potential hazards from septic tank effluents draining into estuarine waters or contaminating ground water supplies have been raised.

The above issues represent potential problems within the Moultrie Creek watershed that require further evaluations. A need exists to determine the significance of identified potential problems to establish which of these concerns require immediate governmental actions and the degree of action needed to resolve each problem. In some cases, early governmental action can be adopted and effectively administered to reduce potential hazards to the health, and socioeconomic welfare of residents, and water and other natural resources. In other cases, further evaluations to establish the most cost effective measures to be undertaken by the County would be the more prudent governmental action. A number of the problems identified require further discussions with residents of the County to determine the extent of local concerns. This process of public discussion of potential problems is highly recommended. Residents' concerns and their willingness to support measures that require higher levels of technical information and greater governmental constraints on development actions must, in effect, guide the decisions of the County Commission.

As development pressure occurs in other parts of St. Johns County, some problems similar to those identified in the Moultrie Creek watershed will be identified. The County does not have sufficient funds to undertake detailed investigations of all potential problem areas. A priority schedule of topics and locations where detailed technical studies are needed must be developed. This effort is being undertaken by the Engineering Department. A schedule of needed investigations will be developed during the 1990 fiscal year.

Every effort will be made by the Engineering Department to obtain supporting assistance for needed studies from other sources. This report was prepared with technical assistance from the U. S. Army Corps of Engineers through the Corps of Engineers State Planning Assistance (Section 22) Program. The Moultrie Creek study was initiated through a Coastal Zone Management Grant from the Florida Department of Environmental Regulation. St. Johns County is now initiating a shared effort with the St. Johns River Water Management District to develop basic topographic and soils information for that portion of the lower St. Johns River basin located within St. Johns County which is currently under heavy development pressure. Soils data for the Moultrie Creek and Moses Creek watershed were digitized for inclusion in the County database through an agreement with the U. S. Soil Conservation Service. Similar data for the lower St. Johns River basin will become available within the next year. Additional studies are needed to determine stream flow characteristics in watersheds under development pressure. The

Engineering Department is investigating current needs and the ability of the County to obtain assistance from the United States Geological Survey for necessary information. Efforts by the Engineering Department to extend essential technical information needed for effective water management through cooperative efforts and various forms of interagency assistance will continue.

Finally, the findings of studies will be prepared for distribution and will be provided to County residents. In some cases, complete reports will be reproduced for distribution at nominal costs. In other cases, summary data and information will be prepared for general distribution. Much of the technical data gradually will be incorporated into the County database system for use by County agencies and the public. Findings of investigations also will be distributed to other governments on a reciprocating basis.

Public and Educational Information

The primary functions of the County Engineering Department can only be accomplished when the majority of residents understand and accept the County's resource management needs. Highly technical information must be summarized and presented in terms readily understandable by residents. The previously noted guidelines represent one type of such information. However, a need exists to prepare general information on technical aspects of water and other natural resource management as a service to County residents.

The County's water and other natural resource management needs are appropriate topics for study and discussion in local schools. The County will cooperate with school system representatives in the development of resource materials for local educational purposes.

Intra-Agency Coordination

Coordination with other agencies of the St. Johns County government occurs at administrative and technical levels. The County Engineer is responsive to activities of other departments that require Engineering Department assistance. Throughout the Moultrie Creek study period, new information developed as a result of the study has been reviewed to determine applicability for use by other departments. Meetings have been held with other departments to exchange pertinent information and to determine the future course of action needed.

On technical staff levels, information exchanges between the Engineering Department and other departments are essential. The Engineering Department routinely provides other departments with a variety of technical information.

Inter-Agency Coordination

The County Engineer regularly meets with counterparts in other local governments and with representatives of regional, state, and federal agencies. Each major development action requires significant coordination efforts to resolve management level problems evolving from the action. Differing technical positions among agencies must be understood and resolved in a manner that satisfies County concerns.

Engineering technology is continually advancing and technical positions of regional, state, and federal agencies periodically change. The County Engineer is required to attend meetings with other governmental bodies when proposed rule changes and technical requirements of those agencies are likely to impact upon St. Johns County.

Through the above coordination activities, the County Engineer can more effectively convey St. Johns County interests and concerns to other agencies. Technical discussions of new engineering advances and other technological changes advanced during the coordination process permit the County Engineer to identify new programs and sources of technical assistance that would benefit the County.

Coordination with other governmental agencies also is undertaken by the Engineering Department's technical staff. Much of this process occurs during the exchange of technical information. The process provides valuable insight into the technical operations of other agencies. This process provides guidance on technical procedures that may improve the Engineering Department's operational practices. Regular discussions are held between the County Engineer and internal staff to identify factors that may lead to improved inter-governmental coordination results.

ST. JOHNS COUNTY DEVELOPMENT PERMIT APPLICATION PROCEDURES

Clearance Sheet Procedures

The following is a summary of the current process required by any individual interested in undertaking a development action within St. Johns County.

1. A Clearance Sheet must be obtained from the 911 office.

   a. The St. Johns County Clearance Sheet for Building Permits outlines the entire process required for all construction and mobile home permits.

   b. The 911 office maintains a database of street addresses for mailing and emergency purposes. This office requires the applicant to verify the property owner, legal description of the property, the public street to which the property driveway is connected, and the address of the property. The office then records the real estate tax number and a tax assessor's map number on the Clearance Sheet.

   c. The 911 office is located at 4425 Avenue A, Building A, located immediately off Lewis Speedway Drive and across the street from the County Administration Building.

   d. Telephone Number (904) 829-5722.

2. Once the Clearance Sheet process at the 911 office is complete, the applicant continues the processing procedure at the Engineering Department. The Engineering Department assigns a file number to the Clearance Sheet and performs the following:

   a. establishes a census tract location for the property;

   b. determines the National Flood Insurance Program zone number, Flood Insurance Rate Map Panel Number, determination of whether the property is subject to flooding or is in a floodway or velocity zone, the first floor elevation criteria requirement;

   c. determines whether the property is located on undrained hydric soils. Proposed developments on undrained hydric soils normally may require wetland permits from the St. Johns River Water Management District, the

U. S. Army Corps of Engineers, and/or the Florida Department of Environmental Regulation. The wetlands permit will establish the jurisdictional line for the wetland and those development actions that are permitted in the wetland. The Engineering Department notes the jurisdictional line, and;

d. establishes the types of utilities planned (well, public water system, septic tank, sewer system) and written proof of the arrangements undertaken for these services. An Engineering Department release is part of the Clearance Sheet process if the applicant intends to apply to the Health Department for a septic tank permit. The Engineering Department also;

e. establishes, as applicable, the location of the proposed development with respect to the County's coastal building zone;

f. establishes the type of access required for specific types of developments abutting specific classes of roads in the County;

g. establishes criteria and adequacy of plans for, property drainage.

h. The Engineering Department is located in the County Administration Building at 4020 Lewis Speedway Drive;

i. Telephone Number (904) 824-8131, extension 207.

3. Following completion of the Engineering Department review, the next permit processing step requires a review by the Planning and Zoning Department. The Zoning review:

a. establishes the property zoning category and zoning district;

b. establishes pertinent physical characteristics of the property;

c. establishes any other zoning restrictions or problems associated with the property;

d. determines whether County subdivision requirements are met;

e. establishes other significant information to be noted regarding division of the land, and;

f. for commercial and multifamily properties, determines the applicability of the County Landscaping requirements.

4. Application for an actual building permit from the Building Department follows the above steps. The Building Department requires completed Clearance Sheet information as a basis for a separate application process to obtain a building permit, electric permit, plumbing permit, and mechanical permit. In addition to Clearance Sheet information, the Building Department requires the following prior to issuance of a building permit:

a. Notice of Commencement;

b. Completed arrangement for utilities and/or necessary Health Department permits;

c. Completed and signed building permit application;

d. Building Department information sheet;

e. Three sets of structure design plans;

f. Completed energy compliance forms;

g. Flood hazard information and first floor elevation restrictions, as applicable.

h. The Building Department is also located in the County Administration Building.

i. Telephone Number (904) 824-9185.

During the above process, the Engineering Department must approve final paving and drainage plans and road and bridge plans for projects requiring site plan review and approval, pursuant to the Ordinance 86-4. These approvals are required prior to issuance of a building permit. Due to manpower limitations, no further Engineering Department reviews are normally conducted prior to final issuance of a Certificate of Occupancy.

Permit Application Improvement Needs

The above Clearance Sheet process is complex, costly to applicants, and costly to taxpayers to implement. The difficulties encountered by a first-time applicant proceeding from initial contact with the 911 office to completion of a project are substantial. The complexity of the existing process is not conducive to the development of even greater development constraints that may be necessary to protect and enhance County water and other natural resources.

As growth continues, changes in the current development application process will be mandated. Confusion in the mind of an applicant becomes translated into frustration. Applicant views of governmental bureaucracy and inefficiency tend to emerge. These views often become attitudes that can lead to difficult discussions related to the application process at each stop the applicant must make. The process can lead to substantial difficulties for application review personnel in each department.

The Engineering Department presently does not have enough trained personnel to perform necessary reviews and inspections. Increasing levels of water, other natural resource, and roadway needs require well-trained staff personnel, and these are difficult to find at salaries the County government can afford to pay. The ability to obtain and retain well qualified personnel can be expected to become more difficult.

The additional staff required by the Engineering Department will dictate the need for more physical space. Other permit application review departments can be expected to experience similar conditions. The permit application process can be expected to result in continually increasing cost to St. Johns County residents. A need exists to clarify and simplify the existing permit application process.

One-Stop Permit Process

Management Premise

A well-managed government conveys to the public an image of providing a positive and desired service. Each contact a government representative has with any resident or his representative conveys a view to the public of governmental management effectiveness and efficiency. The following process outlines some methods by which a positive image of government can be conveyed and actual efficiencies in the permit application process can be obtained.

Clearance Sheet Process

The Clearance Sheet Process can be improved by the following actions.

1. A general guideline document of the development permit application process steps is needed. This document would serve as an initial training device for new governmental employees and as a clear guide useful to all individuals who wish to know more about the governmental development management processes. The guideline document would be written to help the public understand the purposes of governmental imposed constraints upon developments. It would be written to provide clear guidance on the information and materials that must be supplied to the government by the individual. Where additional guidance and detailed direction is necessary, the guideline would provide clear instructions on where to go and what must be done by the applicant to satisfy additional governmental procedures.

   Satisfying the complex requirements of the development permit application process requires significant technical capabilities. The guideline document would clearly describe those technical capabilities necessary for preparing materials for the process. The need for knowledge of sound engineering methods and construction methods would be emphasized. Clear outlines of the technical concerns of the Engineering Department, Planning and Zoning Department, Health Department, and Building Department would be presented. Supplemental guidelines or codes used by each department would be noted and guidance for obtaining these materials would be provided.

   Finally, the guideline document would detail the steps of the permit application process. The Clearance Sheet checkpoint and sign-off requirements would be clearly documented and examples of all other necessary departmental forms would be displayed in the document. Included also would be a description of the stages of the review process and how the permit application moves through the several departments. Telephone numbers of each department would be provided to permit the individual to check on the progress of the review process. Every essential aspect of the permit application process would be identified in the document, including an applicant's waiver and recourse rights and actions.

The guideline document would be prepared as an 8 1/2 by 11 inch document printed in one color for ease in reproduction. It would be structured to represent government effectiveness, without excess. A reasonable price, including publication and expected distribution costs, would be established and noted on the document. The document would be provided without cost to educational institutions and other governments. First time Developers normally would obtain, at a cost, the document as part of a permit application package. The permit application package would include other more detailed department guidelines and criteria.

2. With the guideline document, an applicant could submit an initial application for a 911 review in person or by mail. Instructions in the guideline document would be complete enough to permit individuals familiar with the system to begin the process by mail. Signature and other required verification requirements could be accomplished by any Notary Public prior to application submittal.

An internal permit application review flow process would be established. Each reviewing office or department would receive the application through an internal mail or messenger system. A check sheet would be prepared to note the time and date of receipt and time and date of process completion. Each office or department would have a specified time allocated for initial review. If the application could not be processed within the stated time, the applicant would be notified of the delay by phone and a time extension would be noted on the application check sheet.

If a problem is noted, the applicant would be contacted by phone or in writing, depending upon the number and extent of problems involved, and an appointment could be set up for a discussion session. In some cases, a decision may be made by the applicant to have the entire application package returned by mail. Once an appointment is made with an applicant, that time period is his and any walk-ins or extended meetings would be abbreviated to accommodate the individual holding the appointment time. All phone calls and personal discussions would be noted on the application check sheet. This check sheet would be retained with the permanent file of the application as a reference of the entire process.

If a problem is minor and only procedural, resolution may be possible through a telephone discussion with the applicant. For minor development permits or permits applied for by individuals knowledgeable of the process, it may become possible for most of the process to be conducted by telephone and by mail, with only a limited actual appearance of the applicant.

The above process greatly reduces the need for individuals to appear at governmental offices. Having an applicant function as his own permit application messenger is not cost effective to either the individual nor to governmental departments. Fewer direct contacts with departmental review personnel required by individuals provide more internal reviewer processing time through the elimination of unnecessary and sometimes unproductive discussions with frustrated applicants.

Much of the Check Sheet information is procedural. As County database information is expanded and the geographical information system has wider areal application, the time required in each department for permit application review will decrease. Where the review process identifies conditions that require additional application constraints, the applicant would be notified immediately and, as noted above, a decision would be made with the applicant on necessary follow—up activities.

As the above process is implemented and greater use is made of computer based data and information management, the number of review personnel and space required in each department can be better controlled. Emphasis then could be given to obtaining the highly qualified engineering and other specialists needed to manage complex technical systems and perform essential technical evaluations.

ENGINEERING DEPARTMENT FIELD INSPECTIONS

General

Field inspections are essential aspects of the Engineering Department's routine functions. Staff limitations currently restrict field inspections to critical problems or emergency situations. Every inspection requires travel time to and from the inspection site, time spent at the site, and time spent preparing documentation of the inspection. Many inspections require the participation of two people. With the

Department's current developing staff, on-the-job training is provided during some routine and emergency field inspections.

As noted previously, each field inspection provides an opportunity to add pertinent information on existing stormwater management systems, roadways, and natural areas to the geographical information system databases. Field inspection forms designed to permit subsequent data entry into applicable databases will accelerate the department's data development process.

Application Inspections

Preapplication inspections are conducted for larger and complex developments. Applicants desiring to undertake developments in wetland environments often request County review of project areas.

Current and expected requests for subdivision development permits exceed the manpower capabilities of the Engineering Department. Preapplication field inspections of such developments would require the full time effort of at least one trained inspector.

Construction Completion Inspections

Construction completion inspections prior to issuance of Certificates of Occupancy are not conducted for most development actions due to manpower limitations. Only larger commercial developments with complex road and drainage systems are regularly inspected.

Emergency Inspections

Emergency situations are reported to the Engineering Department on the average of several times each week. These consist of various drainage and roadway problems. Each such inspection represents several man-hours of effort. An estimate 1.5 man-days of effort per week are required by the Engineering Department to respond to the emergency requests.

ENGINEERING DEPARTMENT ORGANIZATION

Current Structure

Figure 10-1. Current Organization of the St. Johns County Engineering Department depicts the staff positions currently funded to undertake daily Engineering Department functions including permitting information management and special projects.

Projected Requirements

Figure 10-2. Proposed Organization of the St. Johns County Engineering Department depicts the immediate staffing needs of the Engineering Department to be requested for funding in the next fiscal year.

PROJECTED ENGINEERING DEPARTMENT PROGRAM

Activity Expansion Needs

Additional capabilities are needed to conduct preapplication and pre-Certificate of Occupancy inspections. One new profesional engineer recently has been added to the Engineering staff, but an estimated two additional full-time employees are needed for these activities.

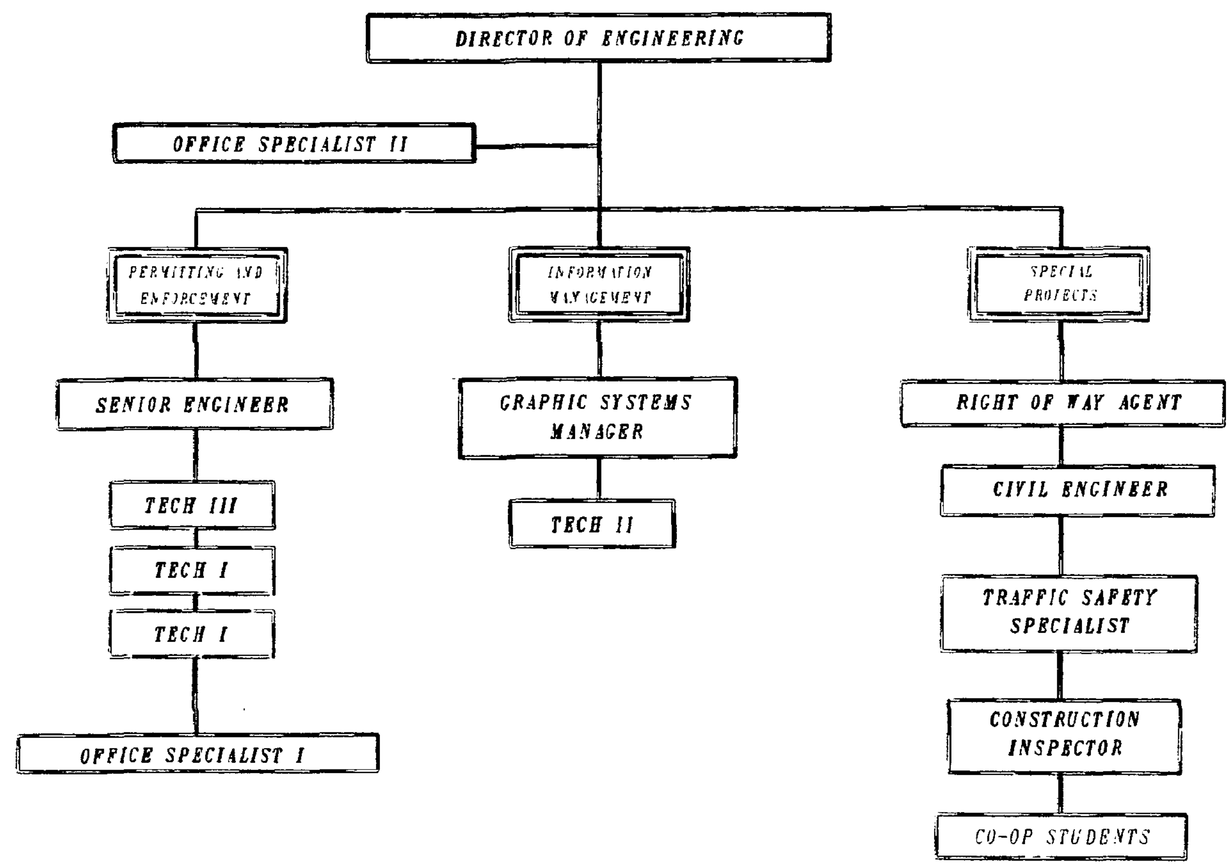
A departmental executive assistant is needed immediately. This individual must be capable of providing routine administrative and supervisory functions while the County Engineer is not present. The individual need not be a registered engineer but must be fully knowledgeable with reference to departmental procedures and functions. This individual must be capable of providing routine operational practice guidance to the technical staff in the absence of the County Engineer. Incoming communications, mail and telephone, would be directed through the executive assistant to the County Engineer.

Additional technical personnel are needed to expand the development of database information associated with the geographical information system. Cost effective operation of the system would entail weekend and nighttime data entry and editing of database information.

Dependence upon the geographical information system and its expansion is expected. A complete management system is needed to assure the proper use and controlled expansion of

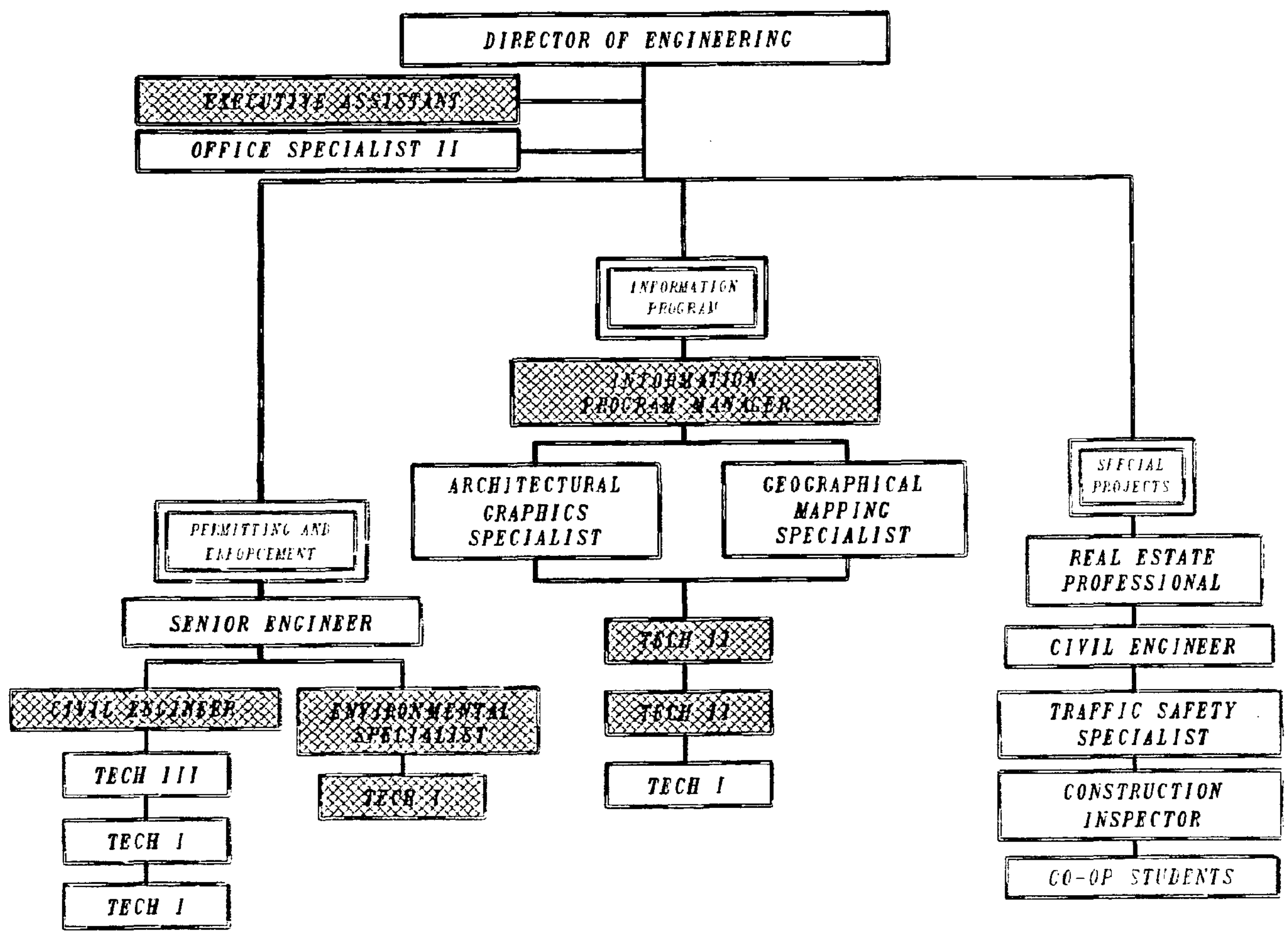
Current Organization of the St. Johns County Engineering Department

FIGURE 10-1



Proposed Organization of the St. Johns County Engineering Department

FIGURE 10-2



the technology. The design of the management system should be developed with a high degree of departmental control. A technical specialist capable of designing and implementing a full range of management procedures is needed. The management system would be developed to assure adequate and proper use of the technology by all departments within the County government. The individual also would be expected to develop management procedures for the inter-governmental transfer of database data to and from other regional, state, and federal agencies.

Engineer Technician Training

The department is going to continue to depend upon engineering technicians for application review and field inspections. These individuals will need progressive on-the-job training. They also will be cross trained as geographical information system operators. All engineering technicians will be expected to access and interpret routine information available through the geographical information system. They also will be responsible for entering new data into digitized form for use in the system when data editing is complete. Those technicians with an interest and demonstrated capability will be given further training in final data editing.

Geographical Information System Development

In coming years, the geographical information system will become a primary source of information used for routine and special functions of the Engineering Department. Other County departments also will become increasingly dependent upon the technology.

The progressive expansion of County capabilities in the use of this technology must be carefully developed to assure continued cost effectiveness. The current equipment must be maintained. Data storage management will require increasing levels of control. Operations will require increasing access control measures and priority use measures. A schedule of expected system expansion requirements must be developed. Cost estimates of equipment, space, and manpower requirements and a priority schedule for system expansion within budget constraints must be developed. Cooperation procedures and cost contributions by other departments also must be developed. System networking potentials and limitations with potential users in other departments must be determined. The special needs of other departments may dictate the need for independent systems, and data exchange procedures then would have to be considered. Finally, the technical decision process regarding the above must be developed and fully documented.

Public Involvement Procedures

County administration decisions would be required prior to consideration of changes in the permit application process. The Engineering Department would be willing to develop the guideline document necessary for the process. The Engineering Department also intends to develop technical guideline information for use by individuals who must prepare drainage and paving plans.

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WATER MANAGEMENT FINDINGS

INTRODUCTION

This report section presents guideline information on water management criteria for consideration in revising the St. Johns County Paving and Drainage Ordinance. The information included represents requirements for an urbanizing area where the interrelated problems of water supply, aquifer recharge, flood control, stormwater management, and significant natural resource area maintenance must given consideration.

Without consideration of the above multiple purposes, the long-term effects upon taxpayers of inaction by a governmental entity can be illustrated by the following extracts from a November 19, 1989, Florida Times-Union newspaper article found on pages A-1 and A-16.

By David Hosansky, Staff Writer

> The $23 million that Jacksonville is spending on drainage projects is just a "drop in the bucket" compared with what needs to be spent on drainage citywide, officials say.
>
> Jacksonville's long-neglected flooding problems have become so overwhelming that an estimated $50 million to $100 million will be needed to provide drainage to just a few of the most frequently flooded areas, such as Hogans and McCoys creeks, officials say.
>
> At least 137 areas in the city exist where flooding can become so serious that people may drown, and evacuation routes and emergency vehicles become blocked, said preliminary information in the city's master stormwater management plan....
>
> After September floods killed two people and stranded hundreds of others, Hazouri

(Mayor) promised a "hurry-up offense" to get proper drainage to aging neighborhoods....

Officials don't even know the full extent of the flooding problems in the city much of which lie in a natural floodplain. A $2 million study on the situation should be completed in two years.

Sixteen projects now are under construction or being designed....

Once the city does get financing for a project, three to five years may be needed to build it, assuming the project is not put on hold. It usually takes that long for city employees or consultants to survey the neighborhood, design the project, acquire right of way, apply for environmental permits and coordinate construction with utility companies.

The city has kept drainage projects on the back burner for decades. Unlike other public works projects, drainage is important only in bad weather.

EXAMPLE ORDINANCES

Ordinances from a number of Florida counties and communities were reviewed to determine methods used by other jurisdictions that could have applicability in St. Johns County. As one example, an ordinance structure has been adopted by Seminole County that incorporates drainage, dredge and fill permitting, wetlands protection, paving, subdivision regulations, and zoning regulations into a land development code. The code presents the individual ordinances in a standardized format and represents a movement by the County towards a coordinated process for managing land development activities. The separate departmental responsibilities are clearly identified.

The Seminole County example represents a simplified codification process useful for clarifying individual departmental functions while eliminating overlapping or ambiguous regulatory statements that can occur in separate ordinances. The procedure also permits improved standardization of terminology and a movement towards a more readable and understandable ordinance presentation format.

The ordinance used by the City of Ormond Beach establishes procedures for a city utility to provide stormwater management services. This ordinance also stipulates the preparation of a water management plan for every new development. Additional useful guidance appears in the fee schedule for development reviews and enforcement functions noted in this ordinance.

The Orange County site development ordinance establishes categories for land development. This procedure provides for improved flexibility in the review of proposed development actions. Design criteria for stormwater management appears in the Orange County subdivision regulations.

Finally, Hillsborough County has established a development review department to manage development actions. Stormwater management purposes appear in the County's site development regulations and subdivision regulations. These ordinances provide information on purposes, procedures, fees, enforcement, and penalties applicable to stormwater management and roadways. The County ordinances reference the **Hillsborough County Stormwater Management Technical Manual**, as the source of design criteria and analysis methods for stormwater management applicable within the County. Similarly, a **Highway and Bridge Technical Manual**, provides design criteria and analysis methods for roadway design. The use of these methods frees the County ordinance from the need to include design criteria that require periodic modification.

Ordinances adopted at different times and for specific purposes essentially reflect orientations, attitudes and interests of individuals involved in preparing the original development restrictions. Revisions undertaken at different times tend to be simple amendments to the original documents. These conditions result in wide variances in different ordinance structures, presentation forms, and resultant interpretations.

St. Johns County could benefit from a review of existing land development management ordinances and some form of unification of separate ordinances. This study has focused upon water management needs within St. Johns County. The following water management criteria reflect some of the management concerns that could be incorporated into a more general codification of land development management procedures.

GENERAL FINDINGS

Purpose

Findings statements are normally included in ordinances. These statements generally reflect the basis of the ordinance. Governmental bodies normally include in the findings statement the general public perceptions of the problem being addressed in an ordinance.

General public attitudes towards stormwater are largely oriented towards drainage, the simpler removal of water. Developing concern for the effects of overdrainage on water supplies and natural resources still requires emphasis. Water shortages are now occurring in northeast Florida, but the relationship between drainage practices and the increased need for landscape irrigation, possibly the major consuming use in urban areas, is not well understood.

Many developers in St. Johns County are following practices of cutting roadways down to obtain fill for raising residential units above 100-year flood levels. This practice has been followed by developers in Jacksonville and elsewhere. When allowed in floodplains and on flatlands with high water tables, the roadways flood following heavy rainfalls. Over time, as storm sewers and other components of the local drainage system deteriorate, the flooding problems become compounded. The long-term result of this practice is illustrated in the above newspaper article on Jacksonville's flood problems. This type of development action, in effect, transfers a development cost from the developer to a future governmental body and the general taxpayers.

Numerous examples of methods and practices exist for preventing a wide range of future problems requiring solutions which eventually become high cost burdens of long-term County residents. Comprehensive stormwater management in St. Johns County is readily achievable. The costs of implementation would be largely a developer's immediate cost and not a general taxpayers future cost.

Findings Statement

Uncontrolled drainage and development of land have a variety of significant adverse impacts upon the County's long-term economic development potential; long-term County infrastructural management costs; and the health, safety, and welfare of the residents of the County. More specifically:

1. Uncontrolled drainage can reduce water recharge to the surficial aquifer used as a source of potable water;

2. Uncontrolled drainage lowers water tables, and, thereby, removes water from the surficial aquifer by lowering ground water conditions. This action subsequently deprives wetlands of essential ground water, reduces essential base flow waters necessary to sustain low flow conditions in streams, and results in the need for increased water use for landscape irrigation;

3. Impervious and compacted urban development land surfaces increase the volume and rate of surface water runoff, allowing less water to percolate into the soil and thereby decrease ground water recharge;

4. Construction requiring the alteration of the natural topography and removal of vegetation without compensating water management control measures results in increased stormwater runoff and an increased erosion potential;

5. Uncontrolled stormwater runoff can damage, by floodwaters erosion and sedimentation, public stormwater conveyance systems, roadways, and other essential components of the publicly maintained infrastructure essential to residents and, thereby, results in increased costs to residents while also placing the safety and health of residents in jeopardy;

6. Uncontrolled stormwater runoff can damage and cause the suspension of services provided by public and private utility systems upon which residents depend, and, thereby, can create hazards to the safety and health of residents;

7. Uncontrolled stormwater runoff can cause damages to lower properties through flooding, erosion, and sediment deposition, and these actions can create direct safety hazards resulting in the endangerment to residents;

8. Uncontrolled stormwater runoff from streets and land areas carries increased levels of pollutants into receiving water bodies, degrading water quality and endangering natural biological processes;

9. The increase in nutrients supplied to receiving waters through stormwater runoff from all sources accelerates eutrophication of receiving waters, adversely affecting flora and fauna;

10. Improperly managed surface water runoff interferes with the maintenance of optimum salinity in estuarine receiving waters.

OBJECTIVES

Purpose

The objectives statement in an ordinance establishes the legal purpose of the ordinance. The objectives statement becomes the basis of criteria and specifications to be followed in the preparation of water management plans and in the construction of stormwater management systems.

Criteria

The County recognizes the need for, and encourages, land development that will be undertaken and constructed with:

1. Full regard of the long-term socioeconomic well being of the majority of current and future residents of the County;

2. Full recognition of the development's long term potential impacts upon the area's public and private infrastructure and the developer's responsibility to undertake the development in a manner that will not cause preventable future infrastructure repair, maintenance, and rehabilitation costs attributable to the development to be absorbed by the County and the majority of residents;

3. Full understanding that the County is obligated to protect, maintain, and enhance the immediate and long-term health, safety, and general welfare of all residents;

4. Full recognition that by affixing ones signature to an application for a development permit constitutes a legal and binding agreement between the signer and the County that establishes the signer's acknowledge-

ment of personal responsibility for accepting and adhering to the following land development objectives:

a. To permit and encourage development actions that will not attempt, by any means, to transfer development related costs, that should be borne by the developer through full compliance with established land development and water management criteria, to other residents of the County by lack of compliance or other actions to avoid compliance;

b. To prevent individuals, business organizations, and governments from causing harm to the County by activities which adversely affect water resources;

c. To protect, restore, and maintain the chemical, physical, and biological integrity of significant natural resource areas and water bodies within and contiguous to the County by requiring the preparation of water management plans for all new development actions that:

(1) result in controlled discharge drainage systems designed to provide flood and stormwater control without damaging water and other natural resources, and which, where applicable, provide for ground water recharge;

(2) provide protection of natural systems and use them in ways which do not impair their beneficial functioning;

(3) provide designed water control systems that function to protect and augment the functions of natural systems;

(4) minimize the transport of excessive nutrients and pollutants to waters within and adjacent to the County;

(5) maintain ground water levels at elevations sufficient to protect water supplies, wetlands, and natural stream base flow conditions;

(6) protect, maintain, or restore natural salinity levels in estuaries;

(7) minimize erosion and sedimentation;

(8) maintain, to the most practical degree, natural fluctuations in levels of ground water and surface water;

(9) protect, restore, and maintain habitats for fish and wildlife.

DEFINITIONS

Definitions required for clarification of water management development criteria appear in the **Glossary** of this report. Specific terms applicable to individual ordinances and to referenced guidelines normally would appear in each document.

WATER MANAGEMENT PLAN APPLICATION

Purpose

The simpler concept of drainage is now included in a broader purpose of stormwater management. As an example evaluation, the Moultrie Creek watershed study served to identify basin-wide stormwater management concepts. The concepts identified included the need to consider the effects of drainage on the surficial aquifer and the need to maintain water table conditions through increased ground water recharge. High water table conditions are also necessary to protect wetland natural resource areas and to extend base flow conditions in natural streams. Runoff water to wetlands must be sufficient to maintain these natural systems, but runoff to the systems also must be controlled.

Runoff also must be controlled to prevent erosion and sedimentation in natural streams. By retaining and detaining runoff on properties, the first flush of pollutants is measurably reduced, and recharge of the surficial aquifer is increased. Detained runoff released to natural systems at controlled rates carries less toxic materials and nutrients to receiving waters. Toxic materials in runoff from roadways are major pollutants, and all public and private roadways should be managed to reduce pollutants from these sources.

The above and other purposes presented as County objectives should be addressed before any development action is approved. A water management plan is a means for presenting an applicant's proposed actions to address all of the County's stormwater management concerns.

Criteria

A water management plan shall be submitted to the County Engineering Department and approved before any private or governmental water management development action is undertaken including:

1. A plat is recorded or land is subdivided;

2. A building permit is issued;

3. Any existing public or private stormwater management system, or attribute thereof, is altered, rerouted, deepened, widened, enlarged, obstructed, or filled;

A water management plan is not required for the following development activities:

1. Agricultural or siviculture activity being constructed and operated in a manner consistent with widely recognized best management practices and not involving artificial drainage of land;

2. Any maintenance, alteration, use, or improvement to an existing structure not changing or affecting the quality, rate, volume, or location of surface water discharge.

A water management plan is not required for any emergency act necessary to prevent the material harm to, or destruction of, real or personal property as a result of conditions, including, but not limited to, fire and hazards resulting from violent storms or hurricanes or when a property is in imminent peril and obtaining a permit is impractical. Following the emergency action by public agencies or private individuals, a report of the emergency action shall be provided to the County Engineer by the responsible administrator of the action agency or by the person responsible for management of a private property within a reasonable period, but not to exceed ten (10) days, following the incident. The County Engineer or his designee shall conduct a field inspection of the site and determine whether remedial action may be needed by the County or private property owner. The County Engineer shall provide to the County

Administrator a cost estimate and recommendations for any required remedial action.

WATER MANAGEMENT PLAN CONTENTS

Purpose

Explicit presentation of the acceptable contents of a water management plan clearly establishes those items that will be emphasized during the County Engineering Department review. The County Engineering Department has the responsibility for assuring that every proposed development is responsive to the County's stormwater management objectives. The types of information required extend far beyond the simpler discharge computations typically used to determine how large a ditch is necessary to get rid of water. The County must provide clear information to applicants, in part, to assist the applicant to follow and the public to accept the County's larger water management concerns. The water management plan content information presented in the ordinance is complex, and will have to be supplemented with additional guidance.

Criteria

It is the responsibility of an applicant to prepare a water management plan with sufficient information to demonstrate full adherence to County water management objectives. All information submitted to the County shall conform with the ordinary professional skill and diligence of accepted engineering standards. The information shall be sufficient to permit the County Engineer to evaluate:

1. The proposed development's impacts upon existing environmental characteristics of potentially affected areas;

2. The potential and predicted impacts of the proposed activity on waters within and adjacent to the County, and;

3. The essential performance and effectiveness of measures proposed by the applicant for accomplishing the water management objectives of the County.

The water management plan shall contain maps, charts, graphs, tables, photographs, narrative descriptions, explanations, system component design specifications, and citations to supporting references based upon the best current and available technology, data, and information, as appropriate for communicating the information required to satisfy St. Johns County water management objectives, including the following:

1. The names, mailing addresses, and telephone numbers of the applicant, property owner, developer, and their agents including, legal and technical representatives.

2. The legal description of the property and its location referenced by state plane coordinates or geographical coordinates and such landmarks as major water bodies, adjoining roads, railroads, subdivisions, and governmental jurisdictional boundaries clearly depicted on a map.

3. A map of the watershed in which the property is located including, sufficient watercourse information to support hydrological and hydraulic determinations of natural and stormwater flows upstream of the proposed development and development runoff discharge downstream of the development to a point where development discharge impacts are negligible.

4. The existing environmental and hydrological conditions of the site, the site outfall locality, the watershed area also contributing to flows at the site outfall locality, and detailed conditions of the receiving waters at the site outfall locality including:

a. The direction, flow rate, and volume of surface water runoff under existing conditions;

b. The location of detention and retention areas on the site where surface water collects or percolates into the ground, including estimates of percolation rates;

c. A description of existing conditions of all watercourses, waterbodies, and natural resource areas on and within 1,000 feet of the site.

5. Site conditions and proposed site alterations including:

a. Seasonal natural water table elevations, the existing seasonal fluctuation of water table elevations, and changes in the existing water table elevations proposed;

b. The delineated locations of flood hazard areas and determined elevations, as applicable;

c. Natural vegetation areas and proposed plantings;

d. Existing and proposed site topography;

e. Soils as determined from the Soil Survey for St. Johns County, Florida;

f. Existing and proposed impervious surface areas;

g. The locations and sizes of buildings and structures;

h. Plans and specifications for all stormwater management structures including estimates of operational system water surface elevations and discharge rates;

i. Plans for control of erosion and sedimentation which describe in detail the type and location of control measures, the stage of development at which they will be put into place or used, and provisions for their maintenance;

j. Other such information which the developer or the County Engineer believes is reasonable and necessary for an evaluation of the development.

CATEGORIES OF WATER MANAGEMENT PLANS

Purpose

It would be unrealistic to require a small residential property owner wanting to build an addition to his home to produce a complex water management plan. Abbreviated forms of the basic management plan requirements are needed for minor development actions. Each of the topics may require some statement from an applicant, but the expected performance and design specifications of stormwater management measures presented in a submitted water management plan may be abbreviated. The actual criteria for types of developments that should be largely exempted from one or more of the management plan component requirements are subjects for St.

Johns County to determine. For example purposes, criteria developed for use in Orange County are noted below.

Example Criteria from Orange County

1. **Category One** - Development that currently contains mostly impervious area and where additional development, and/or site modifications, will cause no increase in impervious area.

2. **Category Two** - Development not covered in Category One above, and is less than ten (10) acres total.

3. **Category Three** - Development not covered in Category One above and is ten (10) acres or more total.

The above criteria require great care in interpretation. For example: Category One could apply to a shopping center or it could apply to a residence that, together with a garage, driveway, patio, and swimming pool, had more than fifty percent of the property in impervious area.

If the County adopts some form of the above type of procedure, the preparation of criteria to establish a locally acceptable category system requires careful review. The possible inclusions and exceptions to each category must be weighed to determine that the County objectives will be adequately met through the use of the system of categories selected.

DESIGN STANDARDS FOR WATER MANAGEMENT PLANS

Purpose

The design of water control systems to accomplish St. Johns County objectives will require a means for informing applicants of all required evaluation criteria. Technical requirements for undertaking necessary evaluations requires higher levels of professional competence than are required for simple ditching and draining.

Design requirements appear within the body of ordinances of many local governments. For example, Hillsborough County uses Technical manuals to supplement local development ordinances. The **Hillsborough County Stormwater Management Technical Manual** provides a useful example for this study. The purpose of the Hillsborough County technical manual is stated below:

> The purpose of this Manual is to guide engineers, architects, planners, and developers in the design of stormwater management systems in Hillsborough County. The manual integrates recommended methodologies, design procedures, standards and County stormwater criteria into a single-source document. The intent of the Manual is to (1) standardize criteria and present suggested procedures and design aides, (2) make it compatible to the Hillsborough County Capital Improvement Program and Stormwater Management Element of the Comprehensive Plan. This manual represents a coordinated effort to bring water resource managers, developers and designers up-to-date with the regulations and criteria applicable to stormwater management design in Hillsborough County. As an integral part of the Hillsborough County Stormwater Management Master Plan, this manual will be utilized by Hillsborough County for permitting, study, review, and design.

The complexity of modern water management technology requires substantial technical definitions and specification details that can be readily separated from the legal and administrative body of an ordinance. Technical criteria and design standards can be incorporated into separate technical guideline documents. These guideline documents would be referred to in the actual ordinance and, by such reference, become addendum documents to the ordinance with a legal basis parallel to the ordinance.

Producing technical criteria and design standards in a separate guideline document has the following advantages:

1. The technical guideline document can be expanded without modifying the basic ordinance as methodologies, material specifications, and technical criteria change to meet new needs and changing technology. Revisions could be handled administratively under the direction of the County Administrator.

2. The document can be expanded to include examples of acceptable procedures for meeting County criteria. These procedures would be presented as suggested methods and would not be considered as mandatory.

3. The document could also serve as a single source of criteria, standards, and suggested procedures for use by the County government, for all stormwater man-

agement works constructed for the County, and for all stormwater management works constructed by individuals with the intent of requesting the County to accept the works within a public system.

4. The document could serve as a training and educational device for new employees and as educational information for the public. As an educational device, the information included could be further expanded to illustrate County purposes for the required criteria and standards.

Technical Guideline Outline

The following outline is based upon the Hillsborough County Stormwater Management Technical Manual. The outline is intended as an example only. The contents of a guideline document prepared for use in St. Johns County would present those criteria, design standards, procedures, and other materials considered locally applicable.

STORMWATER MANAGEMENT
TECHNICAL MANUAL

TABLE OF CONTENTS

3. General Drainage Standards/Criteria
   Requirements Applicable to all Developments
    Requiring Review
      Drainage Review
      Outfall Conditions
      Capital Improvement Program Coordination
   Developments in Floodplains
      Criteria For Development
      Interagency Jurisdiction
   Stormwater Management Data Requirements
      Drainage Area Maps
      Stormwater Design Calculations
   Drainage Easement Criteria
      General Criteria
      Enclosed Stormwater Conveyance Systems
      Canals and Ditches
      Detention and Retention Ponds
      Ingress/Egress

4. Determination of Storm Runoff
   General
   Rainfall Criteria
      Rational and Modified Rational Methods
      SCS Synthetic Unit and Santa Barbara Urban
        Hydrograph Methods
   Time of Concentration
   Rational Method
   Modified Rational Method Inflow Hydrograph
    Approach
   SCS Synthetic Unit Hydrograph Method
   Santa Barbara Urban Hydrograph Method
   Modified Santa Barbara Method Computation Format

5. Culvert and Bridge Design
   General
   Culvert Design Criteria
   Culvert Design Procedures
   Materials Specifications for Culverts to be
    Maintained by the County
   Bridge Design

6. Storm Sewer Design
   General
   Design Criteria
   Design Procedure
   Storm Sewer Tabulation Form

7. Detention and Retention Ponds
   General Criteria
   Detention Ponds
   Retention Ponds
   Detention/Retention Pond Analysis

8. Roadway Underdrain Design
   Roadway Underdrain Criteria

9. Non-roadway Ditch Design
   General Design Criteria
   Utilities Crossing Ditches

10. Roadway (Pavement) Drainage Design
    General
    Elevation of Low Edge of Pavement
    Minimum Roadway Grades
    Minimum Roadway Cross Slope
    Design Frequency
    Runoff Determination
    Concrete, Curb, Gutter, and Sidewalks
    Grassing, Mulching, and Sodding
    Roadway Ditches
    Street Drainage

Many of the topics included above would be appropriate for use in a St. Johns County Technical Guide. All criteria and specifications presented in local ordinances applicable to stormwater management would be included in the technical guide. St. Johns County review agencies regularly encounter a variety of difficulties in the application review process. Prepared information to address many of these problem areas can be usefully expanded upon in the prepared technical guide.

FEES

Purpose

Significant costs are incurred by St. Johns County during the review of an application for a development permit. Much of these costs should be a burden of the applicant.

A pre-application conference is highly desirable. This meeting probably should be a County cost, but its use would result in fewer application processing problems and subsequent negative applicant actions.

Example Fee Schedule

The following standardized fee schedule used by Ormond Beach provides some guidance for consideration:

Industrial, Commercial, Subdivisions, and Multi-Family Residential, Including PUD's

BASE FEE $200.00

Plus $15.00 per acre for each acre or fraction thereof up to 10 acres

Plus $8.00 per acre for each acre or fraction thereof over 10 acres up to 40 acres

Plus $5.00 per acre for each acre or fraction thereof over 40 acres up to 160 acres

Plus $2.00 per acre for each acre of fraction thereof over 160 acres

Miscellaneous

BASE FEE $100.00

Plus $7.50 per acre for each acre or fraction thereof up to 10 acres

Plus $4.00 per acre for each acre or fraction thereof over 10 acres up to 40 acres

Plus $2.50 per acre for each acre or fraction thereof over 40 acres up to 160 acres

Plus $1.00 per acre for each acre or fraction thereof over 160 acres

ENFORCEMENT AND VIOLATIONS

Purpose

The purpose of a water management ordinance and the meaningfulness of the stated County objectives are determined by the willingness of the County to undertake enforcement actions. Enforcement actually begins with the actions of the County Engineer in approving and disapproving proposed development actions. Each reversal of a departmental determination by administrative action sets precedence for development actions unacceptable to the County. When administratively approved development actions are outside of the terms of the ordinance criteria and design specifications, the administrative action constitutes a precedent that can diminish the effectiveness of the ordinance. Other individuals learning of an accepted action not in conformity with the ordinance can legally demand equal or parallel treatment. The ordinance can then become essentially void and noneffective.

The ordinance is also reduced in effectiveness when violations are overlooked or are forgiven. The strictness of enforcement actions must be acceptable to the public, and, therefore, the structure of the ordinance and the design of enforcement mechanisms for stormwater management in St. Johns County must be developed with the consent of residents.

Criteria

Enforcement actions should be standardized and documented. Environmental enforcement procedures in federal and state agencies are moving towards the greater use of administrative processes for civil actions.

Once a standardized administrative fine system is established, the Engineering Department would make the determination of actions occurring in violation of County criteria and design specifications. The County Administrator or his designee would then levee the fine.

The administrative enforcement procedure would be established through the local ordinance process as one of a system of enforcement mechanisms. Included in the ordinance could be a parallel system for resolving violations using the state judicial system. Under the above administrative process, the judicial process normally would be a recourse action for an individual.

The ordinance also could include other actions of the County to insure maximum compliance with established criteria and specifications. County Engineering Department criteria and design specifications should be based upon current and applicable professional standards. Registered professionals who affix their signatures and registration seals to documents are certifying that the ordinary standards of their profession have been applied to the information in that document. Significant deviations from professional standards on the part of members of registered professions are matters that should be directed to state professional registration agencies. The County's intent to follow such redress actions should be included in an ordinance, in guideline documents, and on development permit application forms.

LOCAL GOVERNMENTS PROVIDING ORDINANCES FOR THIS STUDY

Alachua County
Clay County
Duval County (Jacksonville)
Flagler County
Hillsborough County
Orange County
Pinellas County
Seminole County
Volusia County
City of Jacksonville Beach
City of Ormond Beach
City of Port Orange

GLOSSARY OF TERMS

Adverse Impacts – Any modifications, alterations, or effects on a feature or characteristic of waters within or adjacent to the County and significant natural resource areas, including their quality, quantity, hydrodynamics, surface area, species composition, living resources, aesthetics or usefulness for human or natural purposes which are or may be potentially harmful or injurious to human health, welfare, safety, or property; to biological productivity, diversity, or stability; or which unreasonably interfere with the enjoyment of life or property, including outdoor recreation.

Alligator Cracks - Interconnected cracks forming a series of small blocks resembling an alligator's skin or chicken-wire. These cracks are caused by excessive deflection of the surface over unstable subgrade usually as a result of saturated granular bases or subgrade.

Applicant – Any property owner or person, partnership, or corporation, agent, or duly authorized representative who applies for a development permit.

Aquifer - A water bearing stratum of permeable rock, sand or gravel. A body of saturated rock or sediment through which water can move readily.

Artesian Water - Water confined under hydrostatic pressure which will rise in a well when tapped.

Base flood – The flood having a one percent chance of being equaled or exceeded in any given year, according to FEMA.

Base flood elevation – The elevation measured in feet above mean sea level, as shown on a Federal Emergency Management Agency Flood Insurance Rate Map.

Base Flow – Release of water from subsurface storage to a stream flow.

Benthic Organisms – Those organisms which occur at the bottom of a body of water or at the depths of the ocean.

Bond — A form of surety or guarantee agreement which contains the promise of a third party to complete or pay for the cost of remedial action or completion of a construction contract, a subdivider's agreement, a developer's agreement, or a condition or finding certified by an agent which subsequently does not perform as certified.

Borrow Pits – Location of excavation of soil to be used in another location as fill.

Capillary Rise - The distance above the water table and into the less saturated soil that water rises by capillary forces.

Commensurately – Corresponding in size, measure, or amount.

Cone Of Depression - Water-table shape resulting from flow to a well.

Clearing – The removal of trees and brush from the land but shall not include mowing.

Construction - Any activity including land clearing, earthmoving or the erection of structures which will result in the creation of a system.

County - Unincorporated St. Johns County.

Detention – The collection and storage of surface water in a manner that provides for treatment through physical, chemical, or biological processes for subsequent discharge at a rate which is less than the rate of inflow.

Detrital – A product of disintegration, destruction or wearing away.

Detritus - Loose material (as rock fragments or organic particles) that results directly from disintegration. Product of disintegration or wearing away.

Developer – Any person who acts on his own behalf or as the agent of an owner of property and who engages in alteration of land or vegetation in preparation for construction activity.

Development - Any man-made change to improved or unimproved real estate, including, but not limited to, buildings or other structures, mining, dredging, filling, clearing, grading, paving, excavating, drilling operations, or permanent storage of materials.

Direct Evaporation - Evaporation directly from the surface of a body of water.

Discharge point – The outflow of water from a project, site, aquifer, drainage basin, or facility.

Drainage system, natural drainage system – Surface water streams or wetland natural resource areas which convey water to natural points of discharge.

Drainageway Soils - Soils occurring in drainageways as reported by the SCS in the soil descriptions of the Soil Survey of St. Johns County, Florida.

Dropbox – Also called a drop structure. A grade control structure which provides for a vertical drop in the channel invert between the upstream and downstream sides.

Enforcement official – The County engineer or his duly appointed representative responsible for enforcing the provisions of these criteria and insuring plan adherence during and following construction phases.

Engineer – A professional engineer registered in the State of Florida, or other person exempted pursuant to the provisions of Chapter 471, Florida Statutes, who is competent in the field of civil engineering.

Engineer of Record (EOR) – Any individual registered by the State of Florida as a Professional Engineer. Further, the individual must be competent to perform engineering assignments in the specific technical field of Civil Engineering and such engineering practice must not be in conflict of Rule 21H–19.01 of the Rules of the Department of Professional Regulation, Board of Professional Engineers.

Estuary – A water passage where the tide meets a river current.

Eutrophic – Rich in dissolved nutrients but often shallow and seasonally deficient in oxygen.

Eutrophication – The process by which a body of water becomes either naturally or by pollution rich in dissolved nutrients (as phosphates) and often shallow with a seasonal deficiency in dissolved oxygen.

Evapotranspiration - Loss of water from the soil both by evaporation and by transpiration from the plants growing thereon.

Existing – The average condition occurring immediately before development or redevelopment commences.

Final Discharge Points – Point at which the entire flow being considered is discharged into another region or larger body of water, usually a lake or the ocean.

Flatwoods - This type of ecological community occurs on nearly level land. Water movement is very gradual to the natural drainageways, swamps, ponds, and marshes associated with this community. Wet conditions prevail during the rainy season with the water table at or near the surface. It is easily identified by the flat topography and characteristic vegetation. Types of flatwoods include South Florida Flatwoods, North Florida Flatwoods, and Cabbage Palm Flatwoods.

Flood or flooding – A general and temporary condition of partial or complete inundation of normally dry land from the overflow of inland or tidal waters or the unusual and rapid accumulation of stormwater runoff.

Flood plain or flood prone area – Any land area susceptible to being inundated by water from any source.

Floodway – The channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in a manner that the 100–year return frequency flood discharge can be carried without increasing flood heights by more than one foot. The location and extent of floodway areas are defined in the Flood Insurance Study for St. Johns County, published by the Federal Emergency Management Agency (FEMA), revised September 18, 1985, and as may be amended from time to time.

Flood hazard area – A land area within St. Johns County determined by the Federal Emergency Management Agency and displayed on Flood Insurance Rate Maps prepared by that agency as being subject to flooding from a 100–year return frequent flood event.

Flume – An open channel constructed of wood, steel, or reinforced concrete and used to convey water for various purposes, including grade control.

Hardwoods – Periodic or seasonal flooding is characteristic of this ecological community. Hardwoods are often associated with adjacent swamps.

Hydric - Characterized by or requiring an abundance of moisture.

Hydric Hammocks – Moderately moist regimes without excessive water or drought conditions characterize this community.

Hydric Soils – Soils that are sufficiently wet under undrained conditions to support the growth and regeneration of hydrophytic vegetation. The list of these soils includes hydric soils that are either drained or undrained; therefore, not all areas of hydric soils support predominantly hydrophytation and thus are not wetlands. Soils designated by the SJRWMD which have the characteristics of being inundated or saturated on an average of 30 consecutive days per year.

Hydraulic Gradient - The total head loss divided by the length of flow in a drainage structure.

Hydrologic Cycle – The movement of water and water vapor from the sea to the atmosphere, to the land, and back to the sea and atmosphere again.

Inundation – Completely covered by a flood.

Land – The earth, water, air, above, below, or on the surface, including any vegetation, improvements or structures customarily regarded as land.

Liquid Limit - The moisture content at which the soil passes from a plastic to a liquid state.

Lot – A portion of land identified as a single unit in a subdivision and intended for lease, transfer of ownership, use, or improvements; or a parcel, or a tract. Such land consisting of sufficient size to meet minimum development requirements, and such land having an assigned number, letter, or other name through which it may be identified.

Mounded Ground Water - Groundwater which follows the contours of the land surface through an increase and decrease in elevation (as in a hill).

Muck - Dark colored, finely divided, well decomposed organic soil material.

Natural flow - The rate, volume, and direction of the surface or ground water flow occurring under natural conditions in any given portion of the County.

100–Year Return Frequency Event – A precipitation event which can be expected to occur on the average of once every 100 years or which has a 1/100 (1 percent) chance of occurring in any given year.

Parent Material – The unconsolidated organic and mineral material in which soil forms.

Peat - Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture.

Perched Water Table - A surficial aquifer, usually limited in extent, above an impervious stratum which separates the perched water table from a larger, more significant aquifer. A water table separated from the main water table beneath it by a zone that is not saturated.

Percolation - The downward movement of water through the soil.

Permeability - The quality of the soil that enables water to move downward through the soil profile.

Perviousness - The degree of permeability.

Plastic - Capable of being deformed continuously and permanently in any direction without rupture.

Plat – A map or a delineated representation of the subdivision of lands.

Porosity - The ratio of the volume of intertices of a material to the volume of its mass. The percentage of a rock's volume that is taken up by openings.

Positive Drainage - Drainage of a soil, usually an aquifer, which removes more water than can naturally or than is artificially recharged. This type of drainage permanently lowers the water table below the level at which the water table naturally occurs.

Potentiometric Surface - The level to which water rises without pumping in a tightly cased well.

Prairies – Occur in shallow depressions in pine flatwood and dry sand pine/scrub oak communities. Inundation is typically seasonal, ranging from 0.5 to 2 feet. Soils are typically shallow organics overlying clay or compact sands. Water reaches prairies either from direct rainfall or runoff from immediately adjacent uplands. Prairies are typically small, isolated perched wetland systems in the upper portion of the watershed.

Private Roads – A cleared or improved street or road located within a right–of–way or easement owned by a home owners association, private individuals or any entity other than St.

Johns County or the State of Florida. Ownership of private roadways shall be vested jointly in all abutting land owners or in a home owners association whose voting members consist of such abutting land owners. Ownership of the private roadway by the developer is not permitted after construction of the private roadway unless he is the sole owner of all abutting properties and agrees that any properties abutting the private roadway which may be conveyed to others in the future will include the use of the private roadway by the lot owners, their guests, invitees, successors and assigns.

Public Roads – A street or road located within a right-of-way owned by St. Johns County or the Florida Department of Transportation. The street must have been dedicated or deeded to, and accepted by, either agency.

Predevelopment conditions – Those conditions which existed before alteration, resulting from human activity, of the natural topography; vegetation; and rate, volume, or direction of surface or ground water flow, as indicated by the best available technical data and information.

Receiving bodies of water – Any water bodies, water courses, or wetland natural resource areas into which surface water flows or ground water seepage reemerges or results in saturated surface soils.

Recharge Capabilities - The ability to annually replace volumes of groundwater.

Retention – The collection and storage of stormwater runoff without subsequent discharge to surface waters.

Return Frequency – Time interval between storm events which produce similar predetermined intensity and runoff volumes which are used in designing surface and stormwater management systems.

Right-of-way – Land dedicated, deeded, used, or to be used for a street, alley, walkway, boulevard, drainage facility, access for ingress or egress, or other purpose by the public, certain designated individuals, or governing bodies.

Riparian Lines – Bank of a watercourse.

Runoff - The precipitation discharged into stream channels from an area. The water that flows over the surface of the land without percolation into the soil.

SCS Curve Number – Values ranging between 1 and 100 that are used in calculating runoff rates by the SCS method. The more impervious a surface, the higher the curve number.

Saddles – Drainage structures to limit discharge.

Saturated Soils - Soils in which all the interstices are completely filled with water.

Sediment – Fine particulate material, whether mineral or organic, that is in suspension in a water column or has been transported by flowing water and has settled on land or within a water body.

Sedimentation facility – Any structure or area which is designed to hold runoff water until suspended sediments have settled.

Sheetflow - Uniform flow of water in thin layers on a sloping surface.

Significant Natural Resource Areas - Conservation areas and preservation areas which include but are not limited to the following types of wetlands, natural water bodies, and uplands: freshwater marshes, shallow grassy ponds, hardwood swamps, cypress swamps, natural shorelines other than natural beaches and dunes, Class III Waters, and sand pine-scrub communities. Preservation Areas include the following types of wetlands, natural water bodies and uplands: coastal marshes, mangrove swamps, marine grassbeds, natural beaches and dunes, Class I and II Waters, aquatic preserves, critical habitat for endangered, threatened or rare species, and State wilderness.

Site – Any tract, lot, or parcel of land or combination of tracts, lots, or parcels of land which are in one ownership, or are contiguous and in diverse ownership where development is to be performed as part of a unit, subdivision, or project.

Slough – An ecological community which appears as an open expanse of grasses, sedges, and rushes in areas where the soil is saturated during the rainy season. Most sloughs are relatively long and narrow and slightly lower in elevation than the surrounding flatwoods or hammocks.

Soil Horizon – A layer of soil approximately parallel to the surface, having distinct characteristics produced by soil-forming processes.

Soil Matrix - Structure and arrangement of soil particles within the soil horizon.

Soil Mottling - Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aereation and impeded drainage.

Soil Profile - A vertical section of the soil extending through all its horizons and into the parent material.

Species - A class of individuals having common attributes and designated by a common name.

Stormwater - The flow of water which results from, and which occurs immediately following, a rainfall event.

Stormwater Management System - The designed collection of facilities, improvements, or natural systems of the project which collect, convey, channel, hold, inhibit, detain, retain, release, or divert the movement of stormwater in a controlled manner. Includes dams, impoundments, reservoirs, and appurtenant works.

Structure - That which is built or constructed, an edifice or building of any kind, or any piece of work artificially built up or composed of parts joined together in some definite manner.

Surficial Aquifer - An aquifer that is at atmospheric pressure.

Surveyor of Record (SOR) - An individual registered under Chapter 472, Florida Statutes. Further, the individual must be in good standing with the Florida Board of Professional Regulation.

Swale - A man-made trench which:

A) Has a top width-to-depth ratio of the cross-section equal to or greater than 6:1, or side slopes equal to or greater than three (3) feet horizontal to one (1) foot vertical: and,

B) Contains contiguous areas of standing or flowing water only following a rainfall event: and,

C) Is planted with or has stabilized vegetation suitable for soil stabilization, stormwater treatment, and nutrient uptake: and,

D) Is designed to take into account the soil erodibility, soil percolation, slope, length, and drainage area so as to prevent erosion and reduce pollutant concentration of any discharge.

Swamps - A poorly drained depression in which water is at or above the surface periodically throughout the year.

Transpiration - The passage of watery vapor from a living member through a membrane of pores.

Turbid Waters - Stream flow that is thick or opaque with sediment.

Vegetation - All plant growth, especially trees, shrubs, vines, ferns, mosses, and grasses.

Water - Any and all water on or beneath the surface of the ground or in the atmosphere. This includes the water in water courses, waterbodies, and natural or constructed drainage systems. Water also includes diffused surface water and water percolating, standing, or flowing beneath the surface of the ground.

Water Management Plan - The detailed analysis and materials prepared to display and provide information regarding any and all development actions that impact water.

Water Quality - Characteristic of the water based on relative turbidity, temperature, amount of dissolved oxygen, and amounts and types of contaminants.

Water Table - The upper limit of the soil or underlying rock material that is wholly saturated with water.

Watercourse - Any natural or constructed stream, river, creek, drainageway, flow-way, channel, ditch, canal, conduit, culvert, drain, waterway, gully, ravine, slough, spillway, swale, wash, and similar natural or constructed area in which water flows in a definite direction, either continuously or intermittently, and which has a definable channel, bank, and bed or bottom.

Waterbody - Any natural or artificial pond, lake, reservoir, borrow pit, or other area which ordinarily or intermittently contains water and which has a discernible shoreline.

Watershed - A region or area bounded peripherally by a water parting and draining ultimately to a particular watercourse or body of water.

Weir - A dam in a waterway to raise the water level or divert its flow. An instrument for measuring or regulating surface water discharge.

Wetlands – Those natural resource areas with normally and periodically saturated soils or with shallow flooded areas and with dominant plant communities adapted to saturated soils and shallow flooding conditions.

APPENDIX

PHASE 2 STUDY PROCESS

PROJECT PURPOSE

A 1979 study was conducted in the Matanzas River under the Florida Coastal Zone Management Program to determine means for saving the local shellfish growing areas for human use. Septic tank drainage and stormwater runoff were identified as the major sources of decreased water quality and contamination of shellfish areas within the Matanzas River.

The progressive deterioration of water quality in the estuarine water in the Matanzas River gradually can be expected to extend to all the water bodies served by the St. Augustine Inlet and to the coastlines adjacent to the inlet. Unless improved management practices are adopted and adhered to by St. Johns County and the City of St. Augustine, the loss of the local estuary's water quality can be expected to be progressive. Shellfish harvesting is now generally prohibited, with some remaining areas "conditionally approved," and the water quality of the estuary now generally falls within a Class III category or waters suitable for fishing and swimming. Only the caring application of well-known management practices related to urban development throughout St. Johns County can arrest this progressive trend towards further estuarine water quality deterioration.

Subsequent to the 1979 study, the St. Johns County Commission adopted a County-wide drainage ordinance and strengthened regulation of septic tanks. However, progressive deterioration of water quality in the Matanzas River and adjacent waters has continued.

The Florida Department of Environmental Regulation has recognized that a local comprehensive basin-wide approach to management of stormwater and other point and nonpoint sources of water pollution is necessary to arrest the ongoing water quality deterioration problem in the St. Augustine area estuary. DER has noted that project by project review and approval of developments without consideration of basin-wide conditions and project impacts is resulting in continued deterioration of estuaries throughout the state.

As a means of assisting St. Johns County and other smaller governments to develop capabilities to undertake the level of management necessary to protect the state's waters, DER supported the County Engineering Department's efforts to undertake a comprehensive surface water condition and management analysis of the Moultrie Creek and Moses Creek Basins. The analysis of surface water conditions was conducted as Phase 1 of the study completed in May 1989. The Phase 2 analysis and the primary focus of this report, is the development of a conceptual stormwater management process for the Moultrie Creek and Moses Creek Watersheds and the development of a computerized information management system that could support watershed level stormwater management in St. Johns County.

INSTITUTIONAL CONSTRAINTS

The St. Johns County Engineering Department has the technical capabilities for undertaking an analysis of existing surface water conditions within the study area. The Department also can conduct comparative evaluations of technical alternatives for reducing pollution to estuaries carried with surface water runoff from roadways and land developments. The existing County Paving and Drainage Ordinance (No. 86–4) provides very limited capabilities for Engineering Department control needed for more comprehensive basin–wide stormwater management purposes.

Effective management of pollutants being discharged to the Matanzas River and other important natural resource areas requires a comprehensive approach to point and nonpoint source pollution discharges with positive participation from a number of local governmental agencies. The effort would require cooperation between the County government and the City of St. Augustine. As importantly, the residents of the County and St. Augustine would have to strongly support governmental actions to undertake a basin–wide approach to reducing the discharge of contaminants to the County's estuaries.

SOCIAL CONCERNS

The need for comprehensive basin–wide management of pollution sources has been recognized by technical specialists in the United States for several decades. The ability to develop effective measures to reduce the effects of pollution have been limited because of the numerous ways that pollutants enter the environment. All governmental agencies are segmented into specialized departments, and the responsibilities and abilities of any single department to participate in a comprehensive program to control pollution is very limited. Finally, most solutions are based upon obscure or technical and costly premises that are difficult to understand and accept.

Technically sound engineering practices that can reduce pollution discharges in stormwater can only be applied to the degree that the residents of the County can understand and accept the usefulness and added costs to projects of these practices. The County Engineering Department rules must balance the application of technically based restrictions to proposed projects and local comprehension and willingness to accept these restrictions. Therefore, the structure of a conceptual basin-wide stormwater management process must balance the technically based constraints of the management process against the community understanding and acceptance of such practices.

Moreover, the County Engineering Department's rules and development evaluation procedures are responsive to only the stormwater discharge part of the pollution affecting the Matanzas River. Technical evaluations of the significance of the various sources of pollution presently cannot determine which pollution sources are more significant than others. Therefore, it is not possible to determine whether more stringent Engineering Department actions, without commensurate actions by other agencies, will be significantly effective in an immediate future time frame. Unless public benefits can be clearly described, public acceptability of a comprehensive basin-wide stormwater management program cannot be assured.

THE STUDY PROCESS

The study's Master Work Plan identified seven major tasks as project objectives. Phase 1 of the study focused upon the completion of tasks 1 through 5. The primary emphasis of the Phase 2 study efforts were oriented towards the accomplishment of tasks 6 and 7.

ST. JOHNS COUNTY DEVELOPMENT MANAGEMENT ACTIONS

St. Johns County is undergoing development pressure that requires expanded capabilities for providing for the citizens of the County. The need for improved methods for dealing with development actions in fair and technically responsible manners has been recognized by the County Commissioners and the County Administration. The Moultrie Creek-Moses Creek watershed Study provided timely assistance to the County by permitting the Engineering Department to focus efforts on the preparation of improved development evaluation tools.

Under the auspices of the above noted study, the Engineering Department established a computerized geographic information system (GIS). The initial system is now being expanded to permit wider use of the GIS capabilities for a variety of engineering and other departmental uses through the addition of a computer aided design (CAD) component which will allow immediate transfer of a floppy disk provided by the developer into the County GIS.

PHASE 1 STUDY PROCESS OBJECTIVES

Specific Phase 1 work objectives were as follows:

1. Develop a comprehensive inventory of areas within the watershed that deserve special management consideration. This inventory will be used as a basis for the following:

   a. Improving coordination and regulation consistency between St. Johns County, the St. Johns River Water Management District, the U. S. Army Corps of Engineers, and DER;

   b. Revising the County's Comprehensive Plan; and

   c. Future resource investigations by state and local agencies.

2. Develop detailed information on topography, soils, flood prone areas, land use, and other conditions pertinent to achieving stormwater management, flood prevention, and resources protection objectives for the study area.

3. Evaluate County ordinances, plans procedures, and coordination requirements regarding development reviews and stormwater management considerations. Identify needed improvements.

4. Use products developed for special area management in the project areas as a prototype for improving flood protection and stormwater controls in critical resource areas throughout the County.

PHASE 2 STUDY PROCESS OBJECTIVES

Specific Phase 2 work objectives are as follows:

1. Development of basin-specific management tools such as detailed future land use map, plan and permit application review guidelines, etc.

2. Assessment of potential stormwater management, flood protection, natural resource protection problems, and management options.

3. Development of recommendations on stormwater performance criteria and formulation of basin stormwater management plans which address priority resource protection and growth needs.

4. Improvement of consistency and support between County, water management district, and state programs regarding stormwater management and infrastructure planning.

PHASE 2 TASK SUMMARIES

Task 6: Assessment of Potential Stormwater Management, Flood Protection, and Natural Resource Protection Problems and Evaluation of Management Options.

This task focused on the review of potential stormwater, flooding, and natural resources problems resulting from projected basin development patterns, uses, and intensities, as well as general population growth requirements. During the evaluation process, regulatory, infrastructure, and other management considerations in the watershed were evaluated. The development impacts on wetlands and water quality are reviewed and evaluated in terms of basin resource protection strategy alternatives. The evaluations undertaken during this task provided a focus for describing Engineering Department water management program concerns.

The assessment process was undertaken within the context of current local government requirements for comprehensive plan updates, growth management planning, development of regional impacts reviews, Florida Quality Development program reviews, routine County clearance sheet reviews required for construction and mobile home permits, and dredge and fill permits. The local agencies responsible for applicable planning and/or review functions were identified. The Engineering Department's review processes were described and means for possible improvement to current evaluation practices were identified.

The Geographic Information System is perceived as a mechanism to most efficiently manage local government operations, including management of growth and development. The GIS has been designed as a product of this basin management program to address several of the tasks within the scope of work. The GIS has many practical applications including near instantaneous updating of graphical information layers illustrating land use and cover, approved development layouts, soil types, topography, ownership boundaries, easements for drainage, septic facility location, wetland boundaries, significant archeological features, zoning, access, utility location, and other characteristics. All of these layers can be used singularly or in combination to review new development proposals and rezonings, retrofit stormwater management facilities, install and modify major utility lines, identify significant natural and cultural resource areas, and evaluate new transportation corridors. The GIS has tremendous potential for local and regional applications. A result of Phase 1 of this study has been joint funding between St. Johns County and the St. Johns River Water Management District for digitized soil coverage for the entire County. In addition, during Phase 2 of this study St. Johns County has jointly contracted with the St. Johns River Water Management District for approximately sixty square miles of topographic aerials to expand the concepts developed be this study County-wide.

A major effort of the study was the formulation of a GIS implementation program to apply the information generated. The first step was to expand the GIS program beyond the Engineering Department to include the County departments with the most immediate need. The departments selected to use the GIS during this trial period in cooperation with the Engineering Department are Planning and Zoning, Emergency 911 (Sheriff's Office), Health Department, and the water and wastewater utility known as Anastasia Sanitary District. Several terminals have been purchased and are being installed for the inputting of data and viewing of information by each department. The reference maps for data entry are the County property ownership maps and the topographic aerials acquired as part of Phase 1. The property ownership maps are manually prepared by the Property Appraiser and then digitized by the Engineering Department for GIS implementation.

The GIS was a highlight of this study because it served as the mechanism to incorporate the objectives of the study within daily local government operations. The tasks within the scope of work were reviewed in light of the specific applications of the GIS. Some of the tasks have received less effort than others because a more practical use of DER Coastal Zone Management funds was made through the implementation of the GIS than could have been made without the GIS data in other non-funded areas such as the retrofitting of facilities.

The County has a tremendous need for uniform, up to the minute maps depicting the existence and characteristics of road, structures, stormwater management facilities, natural resources, etc. The uniformity of these maps is critical for consistency from County department to department. The County has had a severe problem with map updating because, as in most counties, the property appraiser's maps upon which all other maps have been historically based are only updated once a year. This means that all new development is undocumented graphically for up to twelve months after completion. This delay can seriously misrepresent conditions related to well and septic tank location, vegetation and wetlands alterations, new drainage facilities, changes in land use and zoning, and other vital information. Development of the computerized Geographic Information System enables the County to update informational maps instantaneously. As new subdivisions and other types of land use changes are completed, the information will be submitted by the developers and immediately input into the system. The maps will be available to those County departments requiring this sort of information for daily operations. A major emphasis of this study was the design and formulation of a computerized information system which will meet the County's informational needs.

Some recommended changes to the existing development regulations as they relate to County Engineering Department functions have been identified as a part of this study. These recommendations include design criteria for stormwater management system performance,and minimum finished floor elevations for structures and access roads serving new development.

Flood control and flood protection measures were applied within the basin through careful consideration of existing conditions and regulation of new construction within the basin. These objectives were accomplished in two ways: identification of more stringent development regulations, and formulation of a means to update and maintain up to the minute information on development patterns within the basin through use of the GIS.

The identification of corrective measures for existing flooding problems received minimal effort due to limitations in funding. The focus on new construction through revisions to growth management regulations will enable the County to keep pace with its inevitable growth while searching for funds to retrofit existing facilities.

Provision for the protection of natural resource areas was satisfied by recommended changes to the St. Johns County Paving and Drainage Ordinance No.86-4, utilization of the map layers depicting soil types, land cover and flood plain information within the GIS, and through plans to implement of a digitized jurisdictional wetlands map to be prepared and provided by the St. Johns River Water Management District.

Revisions to the existing County Paving and Drainage Ordinance have been initiated during this study. The County Attorney has completed reconstruction of the Ordinance framework to facilitate ordinance implementation and enforcement. One of the major problems with the administration of the existing ordinance has been the lack of specific and enforceable penalties for failure to comply. This report presents revised design criteria for stormwater management system performance. Some new sections within the ordinance will be written to address the objectives of this study and the recommendations within this report. An applicants handbook will also be prepared to present performance standards and procedures for permitting of construction activity within the Moultrie/Moses Creek basin and beyond.

Land Use plans, Zoning and Building Codes will not be addressed in this revision process. Revisions to these regulations will take years to draft and adopt and therefore are considered beyond the scope of this study.

Task 7: Development of Priority Components of a Comprehensive Basin Management Program

During this task, the Engineering Department prepared basic information on local stormwater management requirements. A conceptual County program was identified to incorporate habitat/wetland enhancement features for fresh water discharges into an estuarine environment. The interface factors between a County prepared stormwater management plan for the study area, revisions needed in the St. Johns County Drainage Ordinance, and Engineering Department rules and procedures and suggestions for local actions were addressed.

A Computer Aided Design (CAD) system, has been acquired as part of Task 7 to input new development plans such as Plats, rezonings, DRI's, stormwater management system plans, utility location and other information directly into the GIS system. The CAD will facilitate immediate, automated transfer of development information provided by the developer by floppy disk directly from the floppy disk via CAD into the GIS system, and eliminate the need to manually digitize all plans, plats, etc. from print drawings into the GIS. It will also assist the County in inputting existing basin information to be considered in the review of new development proposals into the GIS. The time limitations inherent in the contract study process prohibited completion of the applicants handbook and adoption of ordinance revisions within the time allowed by the grant contract. Therefore, the acquisition of the CAD system will serve as the first step in developing the primary components of the stormwater management plan. The CAD will serve as the mechanism to implement many of the goals and findings of the study within the daily operation of the County government processing of building permits, right of way improvements, stormwater management system upgrades and development of a Countywide system of development plan documentation and updating.

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